AD-A101 803   CORPS OF ENGINEERS WASHINGTON DC   F/G 13/2

PROCEEDINGS OF A SEMINAR ON WATER QUALITY DATA COLLECTION AND M--ETC(U)

1977

UNCLASSIFIED   NL

1 OF 2

AD A

101803

LEVEL

COMMITTEE ON WATER QUALITY

PROCEEDINGS OF A SEMINAR ON

WATER QUALITY DATA COLLECTION AND MANAGEMENT

25-26 JAN 1977
DENVER, COLORADO

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-	3. RECIPIENT'S CATALOG NUMBER A201 803

4. TITLE (and Subtitle) PROCEEDINGS OF A SEMINAR ON WATER QUALITY DATA COLLECTION AND MANAGEMENT	5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Committee on Water Quality Collection of 11 individual papers edited by R. G. Willey	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Corps of Engineers The Hydrologic Engineering Center 609 Second Street, Davis, CA 95616	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE 25-26 January 1977 13. NUMBER OF PAGES 142
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution of this publication is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Seminar for Corps of Engineers Staff held in Denver, Colorado 25-26 Jan. 1977

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Water Quality, Data Collection, Monitoring Equipment, Data Network Design.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Topics addressed during the seminar include sampling program design, laboratory ananlysis, instrumentation reliability, interagency cooperation, data interpretation and contracting procedures.

(6) PROCEEDINGS OF A SEMINAR

ON

WATER QUALITY DATA COLLECTION AND MANAGEMENT,

25-26 January 1977,

Denver, Colorado.

(11) 1977

(12) 242

U.S. ARMY CORPS OF ENGINEERS

COMMITTEE ON WATER QUALITY

WASHINGTON, D.C.

FOREWORD

A two day seminar on Water Quality Data Collection and Management was held in Denver, Colorado on 25-26 January 1977. The purpose of ~~the~~ This seminar was to provide a forum for Corps of Engineers personnel who are responsible for the development and implementation of water quality data collection programs. Topics addressed during the seminar include sampling program design, laboratory analysis, instrumentation reliability, inter-agency cooperation, data interpretation and contracting procedures. Eleven papers presented during the seminar are ~~contained herein~~ provided, along with a Seminar Summary and Discussion.

The views and conclusions expressed in these proceedings are those of the authors and are not intended to modify or replace official guidance or directives such as engineer regulations, manuals, circulars, or technical letters issued by the Office of the Chief of Engineers.

Accession For	
NTIS GRA&I	☑
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	

CONTENTS

SEMINAR

ON

WATER QUALITY DATA COLLECTION AND MANAGEMENT

25-26 January 1977

Denver, Colorado

COMMITTEE MEMBERS

Dr. Mark Anthony	Ohio River Division
Charles Bradshaw	Lower Mississippi Valley Division
John Bushman	Office of The Chief of Engineers, Planning Division
Dick DiBuono	New England Division
Harry Dotson	South Pacific Division
Earl Eiker	Office of The Chief of Engineers, Engineering Division
Dr. Rex Eley	Waterways Experiment Station, Environmental Effects Laboratory
John Grace	Waterways Experiment Station, Hydraulics Laboratory
Al Harrison	Missouri River Division
Dave Legg	North Pacific Division
Tom Maisano	North Atlantic Division
Dr. Harlan L. McKim	Cold Regions Research and Engineering Laboratory
Milt Millard	Office of The Chief of Engineers, Construction-Operations Division
Ms. Jan Rasgus	North Central Division
Julian Raynes	South Atlantic Division
Charles Sullivan	Southwestern Division
R.G. Willey	The Hydrologic Engineering Center

SEMINAR SPEAKERS

Dr. Mark Anthony	Ohio River Division
Ron Bush	Seattle District
Earl Eiker	Office of The Chief of Engineers, Engineering Division
Dr. Rex Eley	Waterways Experiment Station, Environmental Effects Laboratory
Dr. Bob Engler	Waterways Experiment Station Environmental Effects Laboratory
Darrell Fontane	Waterways Experiment Station, Hydraulics Laboratory
Richard Jackson	Wilmington District
Dr. George Kincaid	Huntington District
Gary McKee	Ohio River Division
Milt Millard	Office of The Chief of Engineers, Construction-Operations Division
Ms. Jan Rasgus	North Central Division
Raymond Vandenberg	Kansas City District

ATTENDEES

ALASKA DISTRICT

Bob Meyer
Eric Yould

ALBUQUERQUE DISTRICT

William Tully

BALTIMORE DISTRICT

Joseph I. Hemler
Edward J. Marcinski

CHARLESTON DISTRICT

Robbin R. Blackman
John L. Carothers

CHICAGO DISTRICT

Norman Niedergang

COASTAL ENGINEERING RESEARCH CENTER

Arthur K. Hurme

DETROIT DISTRICT

Ms. Judy McLane

FORT WORTH DISTRICT

Douglas R. Perrin

GALVESTON DISTRICT

Richard Medina
Raphael Ray Proctor, Jr.
John E. Wong

HUNTINGTON DISTRICT

Eddie W. Nutter

JACKSONVILLE DISTRICT

Glenn F. Williamson

KANSAS CITY DISTRICT

Jerry F. Buehre
Walter M. Linder
Robert L. Pearce

LOS ANGELES DISTRICT

Joseph Dixon
Lee Jauman
Dennis Marfice
Ray Shiraga
Andrew Sienkiewich

LOWER MISSISSIPPI VALLEY DIVISION

Ellison E. Brown, Jr.

MEMPHIS DISTRICT

Brian P. Cole
Richard S. Sullivan

MOBILE DISTRICT

James Harris

NASHVILLE DISTRICT

Richard Connor
Harold Sansing

NEW ENGLAND DIVISION

David P. Buelow

NEW ENGLAND DIVISION WATER QUALITY LABORATORY

Vyto L. Andreliunas
Robert X. Brazeau
Brian J. Condike

NEW ORLEANS DISTRICT

Gary Guhl
James A. Lawrence
Tom F. Pendergraft, Jr.

NEW YORK DISTRICT

William Slezak
Robert Will

MISSOURI RIVER DIVISION

Howard Reese

OMAHA DISTRICT

Walter C. Deane
Jack D. Rose

PHILADELPHIA DISTRICT

Dave Erickson

PITTSBURGH DISTRICT

Mike Koryak

ROCK ISLAND DISTRICT

Bryan Goodrum
Michael T. Werner

SAN FRANCISCO DISTRICT

William J. Brick
Dana F. Roxon

SAVANNAH DISTRICT

James W. Gallagher

SOUTHWESTERN DIVISION

Donald E. Kretzer

ST. LOUIS DISTRICT

Gerald W. Loesch
Theodore S. Postol

ST. PAUL DISTRICT

Bob Engelstad
Dr. Jay Hokenstrom
Dennis Holme

TULSA DISTRICT

John Hill
Thomas E. Horner
Edward D. Lindsey
Loren M. Mason
James C. Randolph

VICKSBURG DISTRICT

James O. Farrell
William K. Stevens

WALLA WALLA DISTRICT

Frank Lane

WATERWAYS EXPERIMENT STATION, ENVIRONMENTAL EFFECTS LAB.

Dr. Paul Becker
Russ Brown
Alfred Ford
Dr. Dennis Ford
Dr. Donald Rathburn
James Westhoff

WATERWAYS EXPERIMENT STATION, HYDRAULICS LABORATORY

Charles Tate

WILMINGTON DISTRICT

Ms. Christina E. Correale

THE COMMITTEE ON WATER QUALITY

By

Janice E. Rasgus[1]

The Committee on Water Quality was formally established by ER 15-2-10, dated 15 December 1975. The members of the Committee are appointed by the Chief, Engineering Division, Directorate of Civil Works, Office, Chief of Engineers. Meetings have been held on a quarterly basis and minutes are published and distributed to each District and Division office.

The Committee is composed of a representative from each Division and several of the laboratories. The Committee provides guidance for developing a comprehensive, coordinated Corps-wide water quality management program. Each member provides input as to the needs, problems and operations of the field, helps provide direction in meeting these needs and provides a pathway for technology transfer. Detailed efforts are accomplished by small work groups and recommendations are submitted to the Committee for consideration and approval.

Specific objectives and responsibilities of the Committee, as well as of each member, include:

1) Maintaining a continuing awareness of the state-of-the-art of water quality;

2) Determining problem areas and recommending studies, investigations and research which will provide techniques and guidance necessary to arrive at adequate solutions;

3) Recommending to the appropriate Civil Works elements in OCE the type, scope and funding requirements of water quality investigations;

4) Reviewing (annually) on-going and proposed programs of research, studies and investigations designed to provide guidance for use in developing efficient design and regulation criteria to meet water quality management objectives;

5) Exercising expert technical assistance on assigned programs;

6) Disseminating pertinent information (technology transfer);

7) Promoting coordination and communication among the various Corps functional elements; and

8) Rendering consulting services on specific problems as may be requested by various elements of the Corps.

[1] North Central Division; Vice Chairman, Committee on Water Quality

The Committee's consulting service is one of its most important functions. A circular has been drafted which describes the procedure for contacting the Committee for this service. Very briefly, the procedure is as follows:

A request for consulting should be submitted to the Committee Chairman through OCE (CWE-HY). Two weeks before the scheduled meeting appropriate Committee members and consultants will be furnished descriptive data on the project, a discussion of the problem and the specific questions to be addressed by the Committee. At the meeting, a detailed briefing on the problem, including technical details related to the questions posed, will be presented to the Committee. Then the Committee will meet in executive session and provide recommendations to the District Engineer.

To date, the Committee has accomplished the following:

1) Provided detailed review of the Phase I Water Quality Research and Development Program. Each phase of the Program will be reviewed by the Committee.

2) Prepared and revised existing ER's related to water quality. Two which have been completed and released are:

a) ER 1110-2-1402, Hydrologic Investigation Requirements for Water Quality Control, dated 18 October 1976.

b) ER 1130-2-415, Water Quality Data Collection, Interpretation and Application Activities, dated 12 November 1976.

3) Assessed training needs and provided recommendations for courses to be held in FY 78.

4) Sponsored the seminar on Water Quality Data Collection and Management.

5) Helped reactivate the Federal Interagency Committee on Coordination of Water Quality and Ecology. Members of this Committee include TVA, BOR and COE.

6) Drafted a Statement of Need for guidance on quality assurance procedures and personnel needs of Corps laboratories which has been sent to OCE. The Committee will continue to study the situation and make recommendations.

The Committee plans to:

1) Investigate a data management system which could be used Corps-wide.

2) Provide guidance for improved water quality data collection.

3) Continue to review and prepare guidance in the form of ER's and reports.

4) Assist in establishing training and research and development.

5) Investigate quality control and contracting procedures.

6) Provide consulting services.

Members of the Committee should be contacted with any questions, concerns or suggestions. These will be brought to the attention of the Committee for discussion. The members of the Committee on Water Quality are:

Dr. Mark Anthony - ORD
Mr. Charles Bradshaw - LMVD
Mr. John Bushman - OCE
Mr. Richard DiBuono - NED
Mr. Harry Dotson - SPD
Mr. Earl Eiker - OCE
Dr. Rex Eley - WES
Mr. John Grace - WES
Mr. Alfred Harrison - MRD
Mr. David Legg - NPD
Mr. Thomas Maisano - NAD
Dr. Harlan McKim - CRREL
Mr. Milton Millard - OCE
Mrs. Janice Rasgus - NCD
Mr. Julian Raynes - SAD
Mr. Charles Sullivan - SWD
Mr. Jerry Willey - HEC

REPORT ON STATUS OF
RESERVOIR/WATERWAY ENVIRONMENTAL RESEARCH PROGRAM

by

Milton Millard [1]

The Civil Works Program of the Corps of Engineers involves the entire spectrum of water resources development for the Nation. The Corps' role in water resources development has traditionally involved planning, design, construction, and operation and maintenance of projects to meet a variety of purposes including flood protection, navigation, water supply, fish and wildlife enhancement, hydropower, water-quality management and recreation.

The national concern for the preservation and protection of the environment has resulted in legislation that makes environmental quality and water quality major considerations in water resources development and management programs. These additional considerations have made our task more complicated and have indicated a need for expedited research on how to respond to these new pressures and increased costs.

In September 1975, the Deputy Director of Civil Works, as part of the Corps' Environmental Action Program, directed a staff study to analyze the actions required to intensify our research programs in water quality and environmental impact. The staff study was completed in October 1975 and recommended a two-phase water quality/environmental impact research effort; Phase I - Problem Identification, Assessment and Program Formulation and Phase II - Program Implementation. In January 1976, Phase I was initiated by a joint OCE-WES team. Between 3 February and 11 May 1976 the team visited all divisions, with the objective of identifying those water quality offices that could be used to develop a research program responsive to their needs. Field personnel representing Planning, Engineering, and Construction-Operations Divisions were encouraged to discuss all their water quality and environmental problems. These discussions clearly indicated that problems fall into three major areas of concern: technical, institutional, and organizational. The technical problems are those that may be amenable to resolution by research. The institutional problems are those that can probably be resolved by a clarification of policy, improved guidance by OCE or identification of statutory and other authorities. The organizational

[1] Chief, Western Section Operations Branch OCE
Construction-Operations Division Representative,
Committee on Water Quality

problems are those that can be resolved by administrative action. In addition to the R&D needs, two recommendations were made by the OCE group, the first being the need for a definition of the Corps' mission in the water quality area and the second a review of the Corps' organization to best utilize its manpower resources. In response to the first recommendation, the following mission statement was developed:

"The Corps' mission is to develop, maintain, and manage the Nation's water resources in a technically sound and economically feasible manner for the purpose of assuring a continuing supply of fresh water, adequate in quality and quantity to meet the demands of public use, including urban and rural withdrawals, streamflow requirements and recreational needs."

It is apparent that this is an all-encompassing statement, but under existing legislation and goals established by higher authorities, the statement reflects the wide range of our responsibilities. A study has recently been initiated by the Chief of Engineers to address the organizational problem. While this action is not necessarily the result of the study team recommendation, it does address this major deficiency.

As previously mentioned, the OCE-WES team visited all Division offices. Subsequent to these visits each Division was requested to formalize its problem statement input, specifically to provide a narrative description of the problem and its frequency and importance; a description of projects directly affected by the problem; in what manner and to what degree; the direct costs associated with the problem; a summary of prior research and development work done, if any, to attempt to solve the problem; any indirect or secondary effects of the problem, i.e., public relations, legal, aesthetics, and any litigation resulting from the problem.

Input from Division offices resulted in 515 problem statements of which 420 were directly applicable to this program and not being addressed by other ongoing research efforts, primarily the Dredged Material Research Program. Of the 420 problems, 54 were of an institutional nature, or of a nature that would not require any substantial research or development for solution. The 366 remaining problems were broken down by area distribution, i.e., reservoirs or waterway and by subdivisions into Planning, Engineering, or Con-Ops. This breakdown was used in the study and development of the problem assessment.

In the course of the field visits and the subsequent input, it was interesting to note a great commonalty of problems that each Division or District considered to be peculiar to their own projects. Review of the input also revealed the need for improvement and standardization of certain practices in the field and laboratory operations, and a need for modification of certain planning and design procedures. It was also interesting to find that the majority of problems impact on the operation and maintenance area.

I won't go into details of the assessment and analysis; however, as a result of evaluation of the input, a research program divided into two areas - Reservoir Environmental Research and Waterways Environmental Research - was developed. Each of these areas was further subdivided into research tasks, each of which will be directed toward satisfying a major Corps need.

In November 1976, a $30 million, 6-year program was presented to OMB and a final draft report on the program was submitted in December. Passback data indicate OMB has approved the program and initial funding is included in the FY 78 budget that has been presented to the Congress. If the program is approved by the Congress, an attempt will be made to initiate efforts in FY 77 through a reprogramming of funds.

Plans are currently being formulated on management of the program. It is proposed that the Divisions and Districts will be given an active role in managing the program through the device of an advisory group. Technical monitoring will be accomplished by a three-man OCE team representing Engineering, Planning and Construction-Operations. Efforts will be made to direct the program to meet specific problems and to develop a system to transfer the technology to the field in a timely and understandable manner.

The program has top level support in the Corps, and in interagency briefings has elicited support from many of the other Federal agencies. We hope that comparable support will be received from the Division and Districts, and we will atempt in this program to meet the everyday operating needs of the Divisions and Districts in a realistic and timely manner.

SAMPLING PROGRAM DESIGN
BY
RICHARD JACKSON[1/]

First, I would like to thank the Committee on Water Quality and the Hydrologic Engineering Center for sponsoring this seminar. I believe it is important for technical specialists to have an opportunity to meet and share ideas. This kind of conference offers that opportunity and I hope it will become the first of many.

The first efforts in water quality collection and analysis in our country were associated with the public health aspects of water supply. These studies were begun at the turn of this century. With time, the Nation's concern for water pollution control supported the advances in technology. We gained much knowledge on point source pollution and stream sanitation. Because of this emphasis, most of the workers in the field have been oriented towards sanitary engineering. Today's demands on the water quality specialist are very complex and require a balanced, interdisciplinary approach.

The range of projects and activities that we as specialists are faced with may be greater than any other agency. Urban studies, evaluations under 33 CFR 209.145, 33 CFR 209.120, 404(b), ocean dumping, stratification predictions and other reservoir design studies, monitoring and analysis of existing reservoirs, and general investigations are all a part of our area of responsibility.

I believe that the priority challenge facing Corps of Engineers water quality specialists today is in the planning area. The new requirements of the "Principles and Standards" to identify environmental quality needs and objectives and the responsibilities we now have under PL 92-500 to justify reservoir storage for aesthetics or other purposes are enormous. We know how to deal with the problems I mentioned earlier. All of us can sample existing reservoirs and manipulate data to our heart's content. Many math models are available and we know how to use them. But there are no models or techniques for finding and quantifying water quality needs in a basin study given limited study funds and a small amount of time. The challenge for us is to be innovative and resourceful. If we are not, we will fail to accomplish our job in the planning area.

Thinking back to the wide range of activities I mentioned a while ago, it is difficult to consider that there may be a single design method that is appropriate for all. There is, however, an underlying framework that can be used and I will first explain that framework and then provide a short example.

1/Chief, Environmental Resources Branch, Wilmington District

The total process can be viewed as a series of steps as follows:

Define the objective
Collect background data
Prepare preliminary plan
Conduct reconnaissance
Prepare final plan

Now, let's begin with the first step. Define the problem and formulate an objective for the study. Our concern may be to establish a baseline or benchmark from which future changes can be measured, to monitor the impact of some activity, to provide input data for a math model, or to provide management data for decision making such as stratification information so that a level of discharge can be established. The possibilities are almost endless. An important aspect of defining the problem or objective will be to establish the scope of the study, i.e., to what extent will we try to answer the question? Here we will always be constrained by time and money. Be realistic and establish reasonable goals for the study.

Once you have established the objective, coordinate with those who have an interest such as EPA, the State, or other groups. It is important to establish agreement or at least some consensus over what the problem and study objective are before you proceed.

The next step in the process is to collect background data. All possible sources should be checked. Traditionally, STORET, USGS Water Quality Data reports, Water Resource Research Institute reports, Sea Grant publications, State agency files, EIS's, and other reports contain water quality data that might be useful. You should also check with local industry and universities for unpublished data. Don't exclude biological data. We have long known that the biology of the area is an indicator of the water quality and in the event that you find no other data, you might be able to estimate ranges of parameters based on knowledge of the biology extant.

We will need maps and/or photographs to locate stations and for other purposes. The sources listed below should be checked.

USGS quad sheets
ORTHOPHOTO QUADS
ASCS photos
National Ocean survey photos
County road maps

Chances are that you will be able to find a suitable map covering the area you're interested in within the District office. Check the project map book and consult with the planners or Design Branch. Don't neglect the public affairs office or whatever office maintains slides. Often, an oblique aerial photo can be useful in conveying valuable information on stream conditions, depth of water, access, etc.

Now comes the difficult but important step of preparing a preliminary plan. This step brings together all that information you have and coupled with your expertise and statement of the problem, molds them into a workable plan that can reasonably be accomplished. What parameters should we measure for? To answer that, we need to know our objective. For instance, if we are concerned about whether our releases from the project meet State water quality standards, then we automatically know what parameters to measure for. They are specified by the standard.

Other questions that must be carefully answered here relate to the type of instrumentation and method of analysis to be used. What preservation is required and what about sample collection technique? Will we have to train the technician or alert him of special precautions? One of the key aspects of parameter selection will be the cost of analysis. Recognize early that this barrier cannot be broken.

Concern for station locations is a concept dealing with the spatial distribution of the parameters we selected above. Each station should represent some area or stream reach in which we can assume that homogeneous conditions exist. The factors we need to be aware of include things like horizontal or vertical stratification. Point source pollution or inflowing tributary streams are examples of horizontal stratification while the differences in temperature and other parameters with depth in deep rivers and reservoirs represent vertical stratification. Be careful also of conditions that may cause the station to be non representative such as density currents after a rainfall or wind induced currents in a lake.

Statistical methods are available for selecting stations. Prerequisites are a good knowledge of the variability of the parameters of interest, confidence level for the data, and some knowledge of the distribution of the population being sampled. If the population is normally distributed and the parameter in question may be considered as homogeneous, then random samples would be appropriate. An example might be the level of dissolved oxygen in a given layer of a stratified reservoir. There we could overlay our map of the lake with a grid. Then using a table of random numbers, designate sample locations. Now that would not work in the vertical direction. Here our population is not homogeneous and we might try a stratified random sampling method.

Before you launch into statistical sampling, ask yourself what decisions will be made based on the data? What is the sensitivity to errors in estimating population parameters? Do I really have enough information to estimate population parameters such as mean and standard deviation? If not, then I can either not use statistical sampling or I can go out and collect data until I feel confident to proceed. Most of the time we will be constrained by time and money from such sampling. Another problem with statistically selected stations is that they may be hard to locate in the field and may not be suitable for sampling when we find them. That imaginary plot we located in the office on a map may turn out to be a sand bar in the field.

What do we do then if we don't select station locations statistically? We use judgment. We assume certain things about the population and then select stations to fit our needs. Many times we choose to collect samples at road crossings where easy access to water is available and sampling time is minimized. Not using statistics means some sacrifice in confidence but in many cases that sacrifice is not significant to the decision making process.

Having selected stations, now we wonder how often must we collect data at that site? Now the data we have on such things as tides and seasonal or even daily differences becomes important. Our knowledge of how time causes changes in the various parameters will guide us. We know for instance that dissolved oxygen will be at its lowest concentration near daybreak and at its highest in the afternoon. Therefore, we can sample continuously, at periodic intervals, or once daily, depending on the questions we are attempting to answer.

At the end of this most important step, we should have a written description of the problem statement and of the sampling effort designed to answer the problem. Maps should be prepared showing sample stations. The parameters, method of collection and analysis, and frequency of sampling should be spelled out. A best estimate of time and cost should also be prepared. The data should be at a scope of work detail so that we could (and maybe will) contract it out rather than doing it ourselves.

Field reconnaissance is a must. You have to confirm the assumptions you made in designing the preliminary plan. Check to see where lodging can be obtained. What about a source of dry ice or other field equipment needs? Run through the motions and see how much time it actually takes to collect and fix samples. Are there suitable launching ramps? Observe currents and wave conditions. Make sure that you can position yourself on station. All of these things have to be checked to make sure your plan is workable.

The final step in the process is to prepare the final plan. You can imagine the process as being iterative. Review the problem and make sure that the objective of the study is correctly stated. Then use the additional information you've gained in the field to adjust the preliminary plan. If you make any significant changes, you may want to coordinate again with the interested parties.

Once you have the study designed and send the crew into the field, continue to monitor its progress. Murphy's Law will always come into play:

"(1) Nothing is as easy as it looks.
(2) Everything takes longer than you think.
(3) If anything can go wrong, it will."

So be prepared to make further adjustments as the study proceeds.

Now, using the five step procedure, I want to quickly run through an example. Questions have arisen about our dredging program. Some of these questions concern the impacts of disposal methods. Therefore, as we approached the beginning of a contract to remove shoals from portions of the AIWW (see figure 1), we decided to collect some information to help us determine future disposal methods. The problem was to provide better information. The objective was to monitor AIWW dredging operations to measure the effects of disposal on water quality.

We collected background information from the Dredged Material Research Program, EIS's, Sea Grant publications, and other documents. The Navigation Branch was very helpful in providing information on the schedule and qualitative characteristics of the shoal material. Photos and maps were collected from the project map book, other Corps studies, ASCS, and USGS.

Step three required us to prepare a preliminary plan. We selected three areas to sample based on constraints of money, time, material characteristics, and disposal methods. The Sunset Beach area (figure 2) had a mucky material to be contained by upland dikes. The Lockwoods Folly area (figure 3) was a coarse sandy area with the material being placed along the ocean shoreline. Finally, the Carolina Beach Inlet area (figure 4) was a sandy area with the material being placed in a diked disposal area.

The parameters were selected based on the types of questions we had received on coordination of EIS's. Turbidity, dissolved oxygen, pH, temperature, and salinity were to be measured in the field and samples were to be collected and analyzed in the lab for Hg, Pb, Zn, and Cu. We decided to collect the samples before, during, and after dredging and that the sampling would be done during flood tide conditions. Flood tide was selected because of expressed concern by a State

agency that flood tides pushed dredged material into shellfish areas. Also, collecting at the same tide condition allowed us to compare results.

A typical transect is shown on figure 5. Note that surf sampling was required at the Lockwoods Folly site. All other areas were sampled totally from boats. Positioning would be accomplished by range flags in the adjacent marsh. Once two flags were aligned, you were then in the transect.

The reconnaissance was helpful but did not result in any significant change in the final plan. I believe that the close proximity and, therefore more familiarity with the selected areas, resulted in a better preliminary plan than is usually the case.

The task of designing a sampling program can be considered a five step procedure. Careful attention to the process and monitoring of the work once it is underway will result in success.

REFERENCES

1. Ball, Melvin Douglas, "Errors To Avoid In Water Quality Collection and Sampling," Proceedings of the National Symposium on Data and Instrumentation For Water Quality Management, Conference of State Sanitary Engineers, July, 1970, pp. 283-292.

2. Kittrell, F. W., A Practical Guide To Water Quality Studies of Streams, U.S. Department of the Interior, Cincinnati, OH, 1969.

3. Mackenthun, K.M., The Practice of Water Pollution Biology, U.S. Department of the Interior, Washington, DC, 1969.

4. Sanders, T.G., Adrian, D.E., and Berger, B.B., "Designing A River Basin Sampling System," Publication No. 62, Water Resources Research Center, U. Massachusetts at Amherst, Amherst, MA, March, 1976.

5. Sherwani, J.K., and Moreau, D.H., "Strategies for Water Quality Monitoring," Report No. 107, Water Resources Research Institute of the University of North Carolina, UNC-Chapel Hill, NC, June, 1975.

6. Shotwell, Henry P., "A Note on Sampling In Water Quality Studies," Proceedings of the National Symposium on Data and Instrumentation For Water Quality Management, Conference of State Sanitary Engineers, July 1970, pp. 310-312.

7. Slack, K.V., et. al., "Techniques of Water-Resources Investigations of the United States Geological Survey," Book 5 Chapter A4, U.S. Department of Interior, Geological Survey, Washington, DC, 1973.

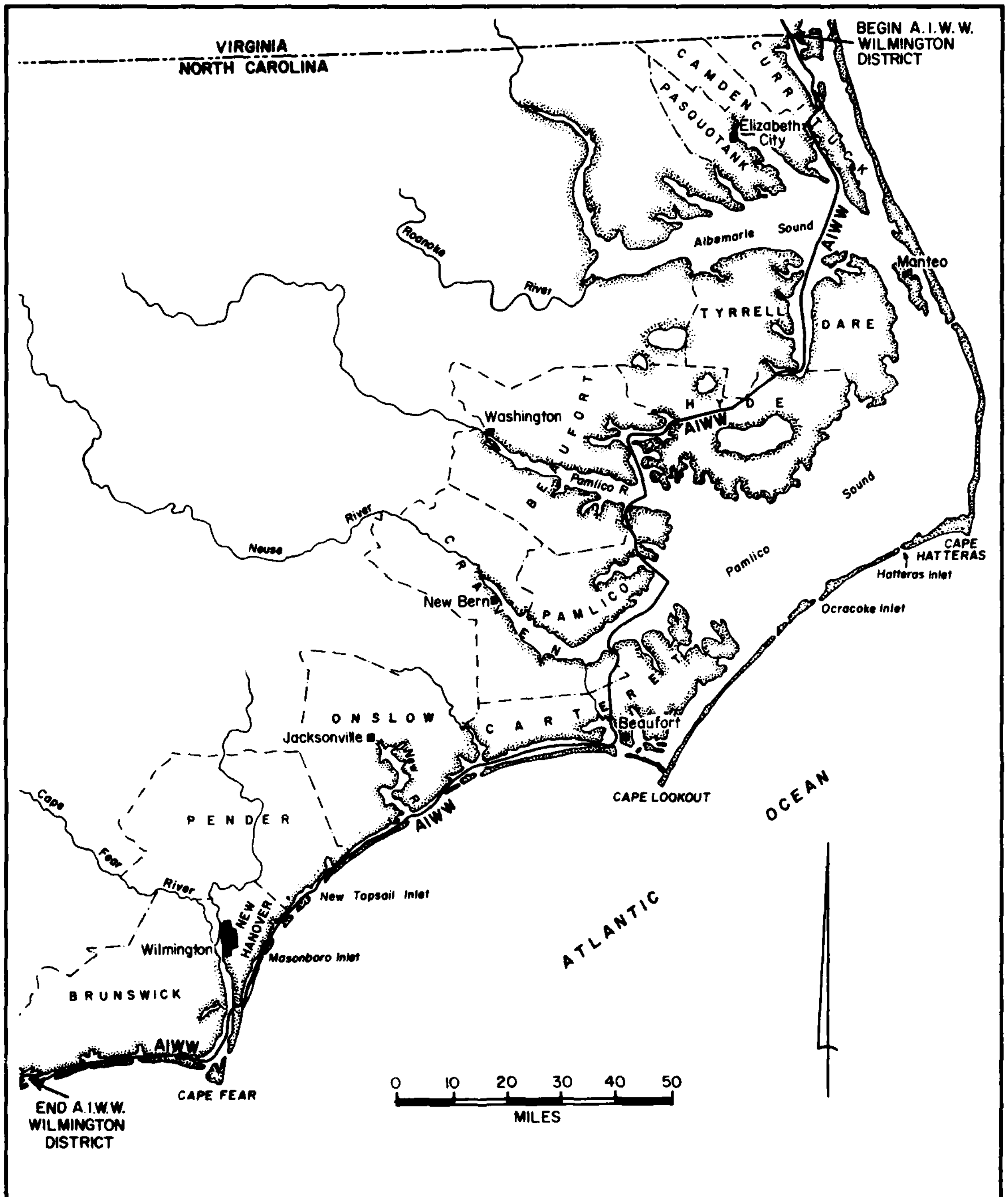
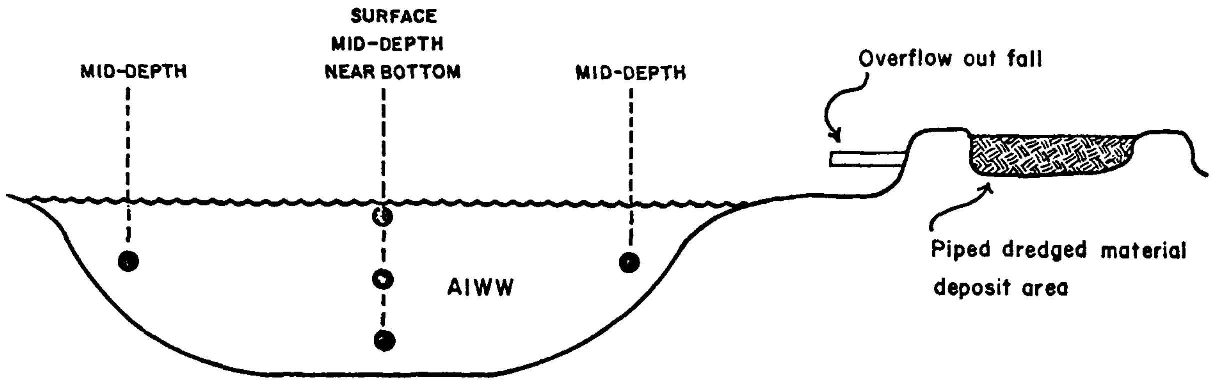


Figure 1

General Location Map
Atlantic Intracoastal Waterway
Virginia State Line to Little River Inlet, South Carolina

CROSS-SECTION OF SUNSET BEACH SAMPLE AREA.



CROSS-SECTION OF LOCKWOODS FOLLY SAMPLE AREA.

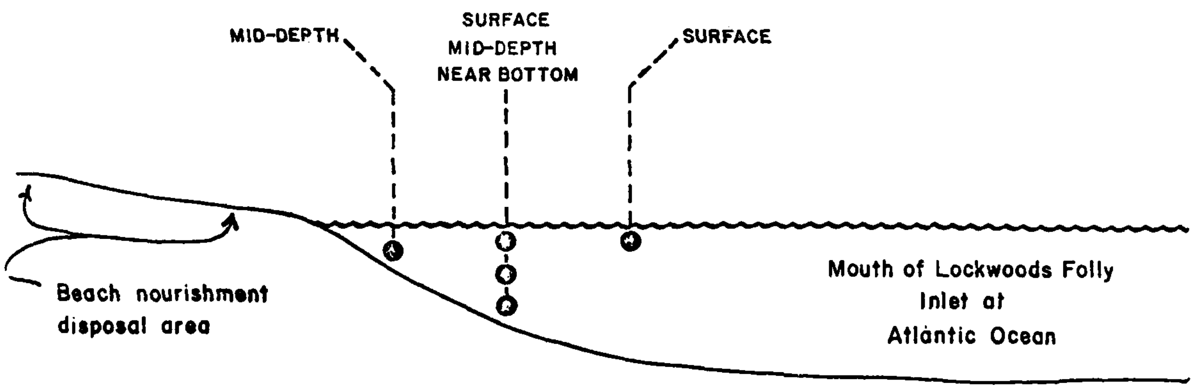


Figure 2

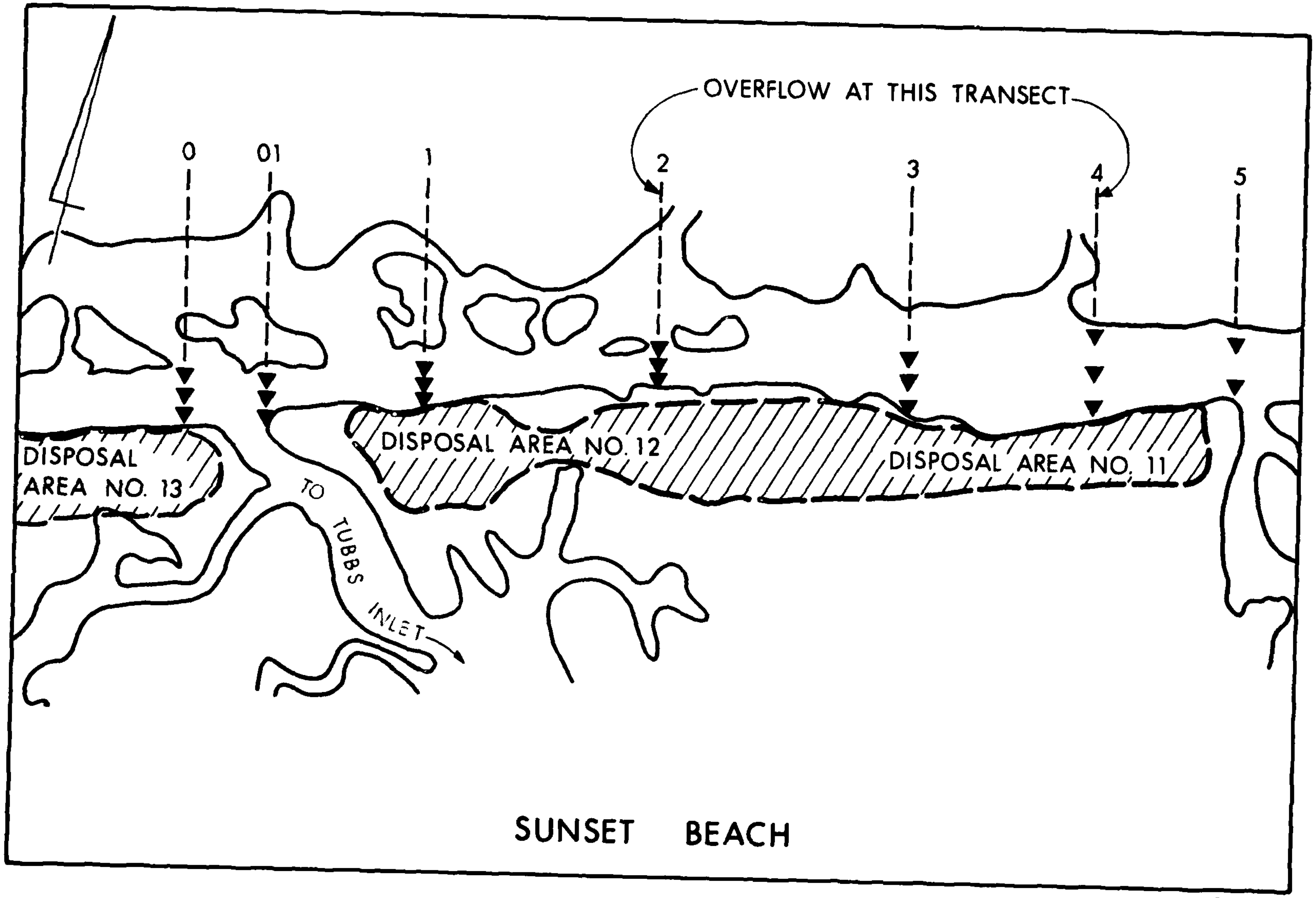

OVERFLOW AT THIS TRANSECT
0
01
1
2
3
4
5
DISPOSAL AREA NO. 13
DISPOSAL AREA NO. 12
DISPOSAL AREA NO. 11
TO TUBBS INLET
SUNSET BEACH

FIGURE 3

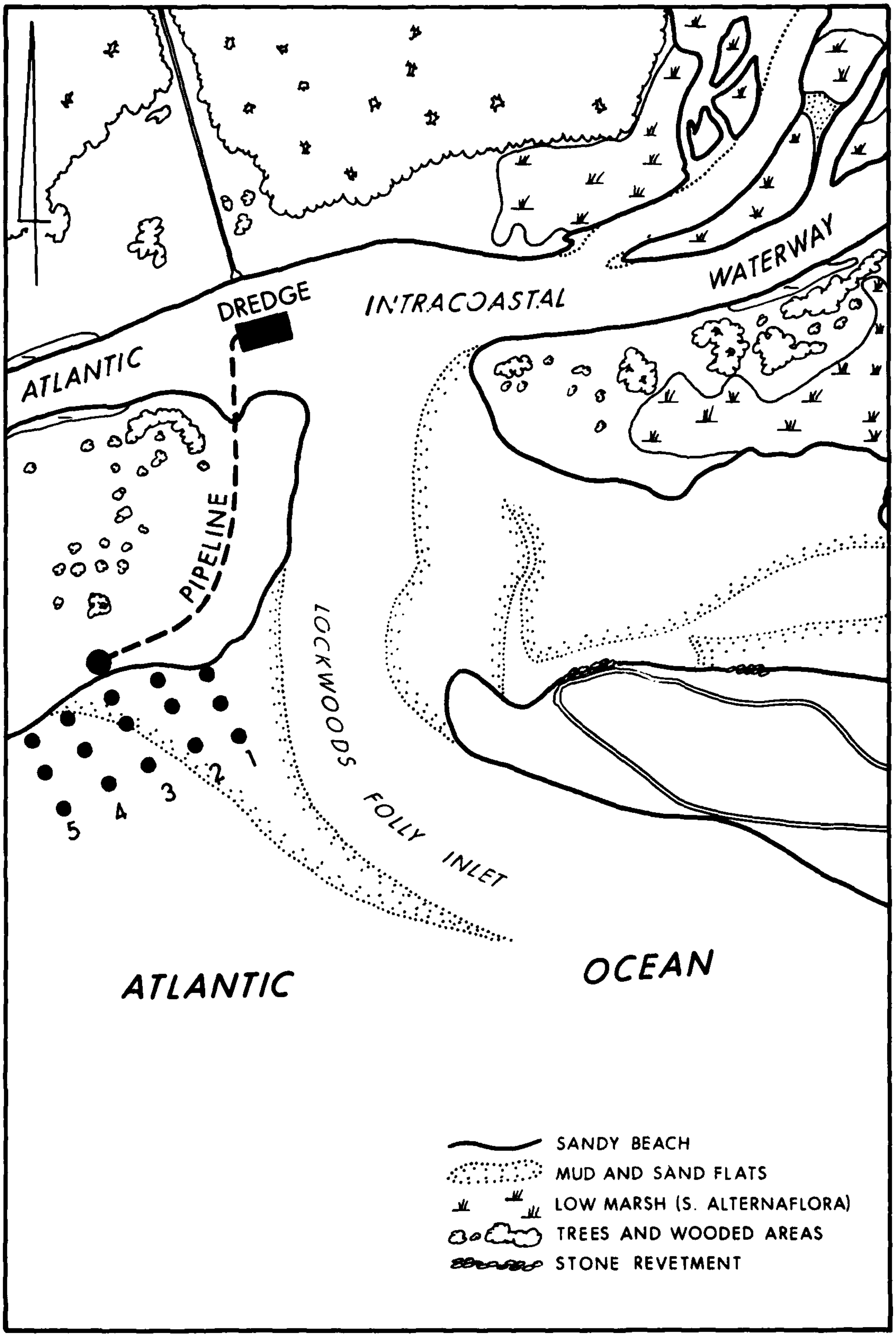

DREDGE
INTRACOASTAL
WATERWAY
ATLANTIC
PIPELINE
LOCKWOODS FOLLY INLET
1
2
3
4
5
ATLANTIC
OCEAN
SANDY BEACH
MUD AND SAND FLATS
LOW MARSH (S. ALTERNAFLORA)
TREES AND WOODED AREAS
STONE REVETMENT

FIGURE 4

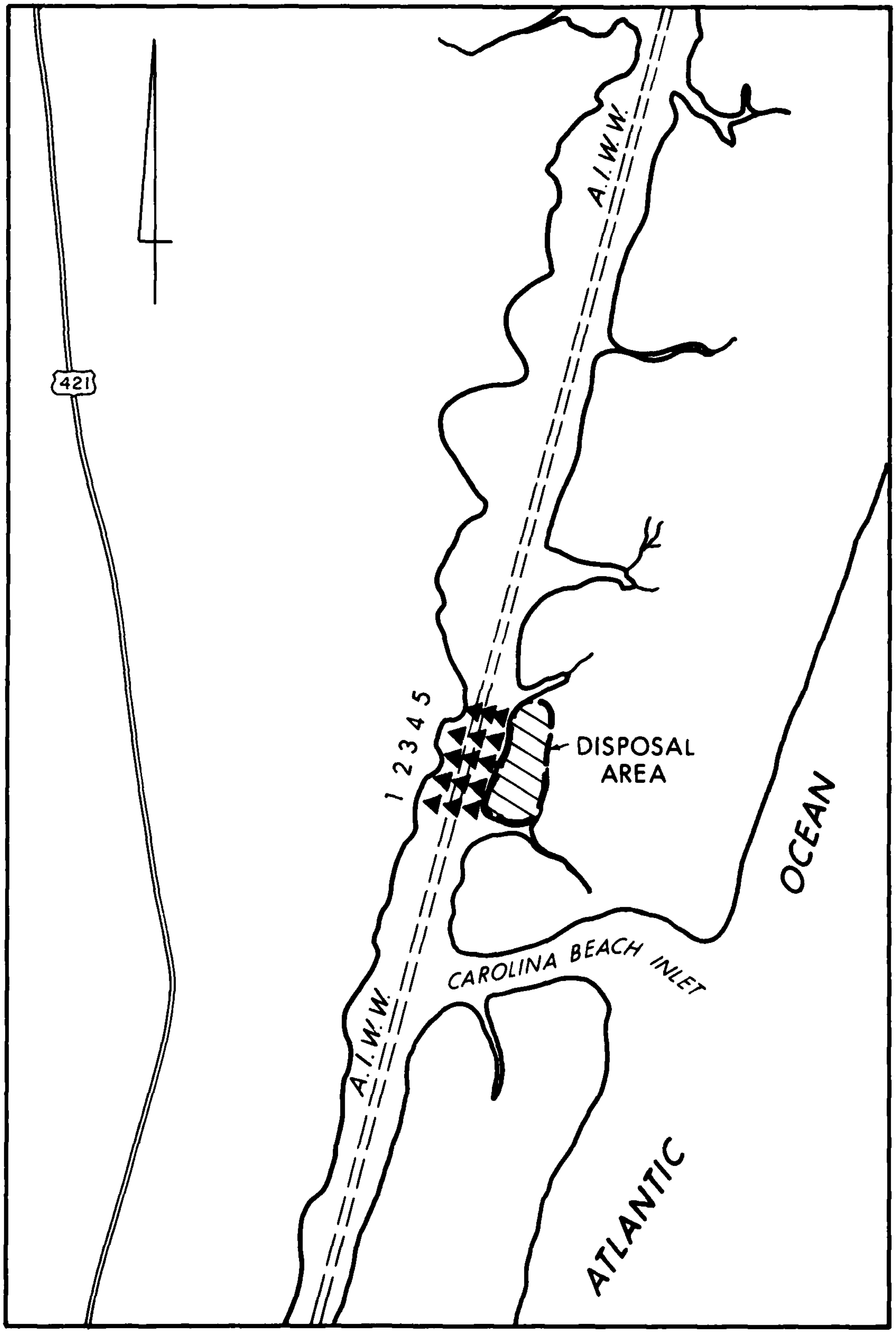

421
A.I.W.W.
1 2 3 4 5
DISPOSAL AREA
CAROLINA BEACH INLET
OCEAN
ATLANTIC
A.I.W.W.

FIGURE 5

DEVELOPMENT AND OPERATION OF A LABORATORY FOR ANALYSES OF WATER QUALITY SAMPLES

BY

GERALD D. McKEE[1]

INTRODUCTION

A water quality laboratory should be considered an integral part of any water quality study. It is not at all autonomous to the study, and to be most beneficial, some of the laboratory personnel should be involved in all phases of a study. The major advantages of laboratory personnel involvement are:

a. They provide an important discipline in selection of the parameters to be measured for a particular objective.

b. They can establish practical limits on the degree of accuracy and precision available versus what is required for each study.

c. They may be able to provide the data in a form suitable for routine data analysis to the data interpreter.

d. They must be involved in the establishment of the work load; one of two equally viable studies may result in a disaster if the work load is unreasonable. The laboratory personnel, with their knowledge of parameter stability, analyses/unit time, available personnel, and other work loads, will not only enable a study to run smoothly but may make it possible.

NECESSITY OF LABORATORY

Establishing the need for a laboratory is generally a difficult task to accomplish. One factor that makes this decision difficult is that if you hire an individual who knows the details necessary to make these judgments objectively, as a staff member he probably will want to develop a laboratory and therefore becomes subjective. It is not easy to hire an independent contractor to make this study because much of the information in the early stages is not concrete information but best guesses. Since this input must come from within the organization, the contractor will probably only be preparing a report based on your decision.

The first item to consider is: (a) identify the parameters that need to be measured. The level of detection, accuracy and precision, and the chemical form required must be established.

The second item to consider is: (b) estimate frequency required for each parameter. The frequency should be defined in terms of number per day, per week, and per month with the emphasis on how often these data are expected to be reported. This is a critical criteria and must be carefully defined in terms of what is actually needed.

[1]Water Quality Section, Reservoir Control Center, Ohio River Division

The time required for analyses is not linearly related to the number of analyses to be completed for many parameters. The following example illustrates the significance of this.

If an adequate preservative is available and data are not immediately required, the laboratory will hold samples until a sufficient number of samples are present in the laboratory to minimize the time required for each analysis. One sample per day analyzed and reported daily for one parameter for 20 days will cost about 3.5 times more than if the same samples can be analyzed and reported weekly and 9 times more costly than if those samples are held for 1 month prior to being analyzed and reported.

These calculations show in a broad sense that if the sample "load" at a laboratory can be increased to near an optimum operation, tremendous cost savings can be achieved while getting rapid turnaround. A lot of sporadic samplings from many projects represent a high rate steady flow of samples to the laboratory.

The next item to consider is: (c) initial costs to provide the available space, equipment and instrumentation, and the personnel slots of appropriate grades to fit the requirements. This can just as easily be overestimated as underestimated. Limited dollars, space, grades, and number of slots may prevent the development of a successful laboratory from being developed, but dollars, space, and grades alone will not guarantee success.

The next item to consider is: (d) adequacy of the physical location of the laboratory. The availability of rapid transportation of samples from collection site to the laboratory and access of the laboratory to support facilities, such as ADP equipment, local quick suppliers of chemicals and gases, and availability to other professionals in these disciplines must be considered in the site selection.

The last item to consider is: (e) continuity. The work load must be of sufficient duration in years to depreciate capital expenditures and recruit the desired personnel. It should also be relatively continuous throughout the year.

Assuming these criteria lead to the conclusion that an in-house laboratory is the best way to meet water quality data requirements, it is time to proceed with the detailed development of the laboratory.

DEVELOPMENT OF LABORATORY

a. Physical Plant. The first criteria necessary to meet is the floor space requirement. General guidance is available that is based on square feet/person working in the laboratory. However, it is also necessary to consider storage space, office space, and special areas dedicated to specific parameters along with the basic floor space requirement.

Within this framework of available floor space, the installation of hoods, benches, storage areas, cleanup areas, and the areas specially dedicated for specific parameters must be considered. In general terms, the laboratory should have a flow of work designed into the bench arrangement with a minimum of people working in the same area at the same time. Office space in "quiet" areas is also required for some of the personnel. Other considerations and requirements of the general location of this space have already been identified.

Laboratory services including distilled and deionized water, gas, vacuum, air, and adequate electrical services are basic requirements, and extreme attention to detail is required for these apparently obvious requirements to be able to meet the requirements of the laboratory. The electrical requirements of two instruments may require separate electrical lines at one bench area if it is planned to put these instruments in the same area. If this is not established in the initial phases, correction afterward may be extremely difficult or may be impossible.

b. Personnel. The laboratory manager should have a minimum of a B.S. in chemistry and a minimum of 5 years experience in this area of activity. It is desirable that he have a M.S. in an environmental study area and at least 10 years experience.

The laboratory manager is technical manager and must perform two distinct duties: management of work load and provide technical guidance. One area cannot compensate for another and although they appear to be seemingly unrelated, the greater the depth he has in one of these two areas, the better he can be in the other. The experienced technical manager can provide technical guidance that will reduce problem solving time by manyfold and make assignments that have a synergistic effect on individual performances to increase the productivity of the overall laboratory.

Below the lab manager, at least three persons are required simply due to the distribution of the type of work. Each laboratory needs a "senior chemist." He should have a minimum of a B.S. degree in chemistry and at least 5 years analytical experience. He should possess all of the technical competence of the lab manager but is permitted the freedom to not get involved in the details of managing the lab. In reality, his technical competence will probably exceed that of the lab manager and this should be the case.

The next required person is "either" a senior technician or a junior chemist. In the case of the technician, he should have a minimum of 2 years of college chemistry and between 8-10 years experience. The junior chemist should possess a minimum B.S. in chemistry and experience is not required.

The other position generally required for a smooth operation is a junior technician becoming a senior technician (minimum requirements of 2 years college chemistry, 0-4 years experience) or it can be filled by a full-time technician with no college and gaining experience or this work can sometimes be performed by part-time college students.

Biological and microbiological laboratory functions may be incorporated into this general framework and contact hours between these various disciplines generally enhance each other.

After a physical plant and proper personnel have been established and selected (these are somewhat simultaneous steps), it is necessary to select the methods that will be used to perform the analysis.

c. Analytical Methodology. Standard, well established methods available for many parameters are published in four basic references: Standard Methods, APHA, AWWA, WPCF; ASTM Standards, Part 31; EPA Methods Manual; and USGS Water Analysis Manual.

In general, these methods are accurate, precise, rapid, and dependable and there are several procedures for one parameter that will permit selection of the procedure and instrumentation most suitable to the specific requirements of the mission.

Current literature provides analytical methods for many parameters and eventually the better methods will survive and be published in the standard references manuals.

The instrumentation is selected on the same basis as the methods; accuracy, precision, speed, and dependability. The overriding criteria in selecting instrumentation is to purchase those that most clearly fit the requirements. If one instrument has a sensitivity several times that required to meet the mission requirements, a sacrifice in needed dependability may result.

d. Quality Control. A quality control assurance program is required and should be considered a part of the work load. Quality control is not something added to a laboratory but it includes assurance that the physical plant, personnel, methods, and instruments are functioning properly. The quality control program documents if all of these facets of the analysis are properly functioning.

This is the responsibility of the lab manager and the documentation assures that the data being produced are valid. This program consists of performing analyses on standards, making replicate analyses, and making standard additions to samples.

Standards are samples prepared with known concentrations of the substance being measured in a known matrix to insure accuracy of all aspects of the analytical procedures except possible interferences in the unknown sample. Standards are used to initially prepare the curves or factors that are used to compute the concentrations of the unknown samples and when spaced throughout the sample run, are used to measure changes that may have taken place since calibration. Reference standards from other labs should be analyzed on a less frequent basis to insure that preparation and analysis of in-house standards are correct.

Replicate analyses, analyzing a sample more than once, should be made during the sample run to insure that the precision is within expected limits.

Standard additions, adding a known amount of the substance being measured into an unknown sample matrix, assures that the unknown samples do not contain positive or negative interferences. The required frequency of standard additions is a function of the type of samples.

These three procedures when used and documented, provide a high degree of assurance that each datum produced is valid within specified limits.

e. Data Reporting. The last item that must be considered is how should the laboratory report these valid results. Data handling prior to the automation of many procedures was not a big problem; at the end of a day, an analyst could sit down for 15 to 30 minutes and prepare a short report by hand; the secretary could type it up in 5 minutes, and in a year, a big lab had one file drawer full.

Now one analyst using one of the typically automated methods would spend over 30 percent of his time transferring data by hand.

ORD has developed a data handling system that requires about 10 percent of the analyst's time, while at the same time, prepares the data sheets, automatically calculates some of the data, does the billing, prepares a priority list of analyses, and creates a retrievable file for the data user. Some of the data handling process is automated even for the nonautomated analytical procedures. Samples arriving at the laboratory are given a sequence number. This number is written on both parts of a tear off tag. One part of the tag remains with the sample and the other part of the tag goes to the ADP unit. Information such as district code, project code, specific sampling location, date, time, depth, and the parameters to be analyzed on that sample are keyed into the computer from the tag. The computer then sorts this information, prepares the bench sheets to be used in the laboratory, generates an empty file for the analytical result when analysis is completed, maintains the status of all samples, and maintains the billing system. The laboratory performs the analysis and enters the result in the proper column on the bench sheet. These bench sheets are then sent back to ADP and the results are entered in the computer in the previously generated file space. These data are immediately accessible to the laboratory, division office, and the district offices and are ready for interpretation.

SUMMARY

This paper has identified the essential items that must be evaluated prior to a decision to develop a water quality laboratory and described the factors necessary for a smooth operation. These items have been generalized and highlighted to provide a general understanding of a water quality laboratory operation.

The development of a well operated water quality laboratory is possible only when all of these factors are considered in detail.

READING BIBLIOGRAPHY

1. American Society for Testing and Materials, 1975, Annual Book of ASTM Standards, Part 31: Philadelphia, Am. Soc. Testing Materials.

2. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1975, Standard Methods for the Examination of Water and Wastewater, 14th ed.: New York, Am. Public Health Assoc.

3. Brown, Eugene, Skougstad, M.W., and Fishman, M.J., 1970, Method for Collection and Analysis of Water Samples for Dissolved Minerals and Gases: Techniques of Water-Resources Investigations of the U.S. Geol. Survey, Book 5, Chapter A1, Washington, D.C., Superintendent of Documents, U.S. Govt. Printing Office.

4. Environmental Protection Agency, 1972, Analytical Quality Control in Water and Wastewater Laboratories: Analytical Quality Control Laboratory, NERC, Cincinnati, Ohio.

5. Environmental Protection Agency, 1974, Methods for Chemical Analysis of Water and Wastes: Methods Development and Quality Assurance Research Laboratory, NERC, Cincinnati, Ohio 45268.

FIELD GEAR FOR WATER-QUALITY STUDIES
CONCEPTS IN PROGRAM DESIGN AND USE OF EQUIPMENT

by

GEORGE P. KINCAID, JR. PH.D.

1. Water quality control is an assigned purpose at many Corps of Engineers projects. Massive investments are at stake and much attention is focused on achieving water quality goals.

2. Water quality problems are, in most cases, project specific and vary in response to such items as location, purpose, and watershed characteristics. Superimposed upon these facts is the knowledge that a multiplicity of both point and nonpoint sources of pollution may affect water quality. Neither the mechanisms of movement in the environment nor the ultimate effects of many of these pollutants are known.

3. Current budgetary and resource restrictions in many cases limit our ability to plan comprehensive programs. Therefore, it is mandatory that state-of-the-art technology be applied in water quality studies. Carefully planned and designed field studies, combined with physical and mathematical modeling, are the most efficient and cost-effective means to develop insight needed to help us solve problems related to water-resource management.

4. Studies can be very indefinite in scope and overall cost. It is important to implement programs that converge on key impact issues for sites under study to prevent accumulation of useless data and unnecessary costs. Even though impact areas must be defined early in project studies and incorporated into focused environmental management programs, all impacts or deviations in water quality behavior cannot be predicted. Therefore, sampling programs must remain flexible to allow necessary alterations in statements of work.

5. Impounded waters are in more or less dynamic states and sampling formats must be designed to detect pertinent variations in quality of inflow, lake, outflow and downstream waters. Concepts taken into account must include the fact that interactive effects exist between water quality and project operations, water quality can be variable in both time and space, baseline or contemporary conditions are subject to change, obtaining data of different

[1] Chief, Water Quality Section, U.S. Army Engineer District, Huntington.

types requires varying amounts of time and response time for implementing management decisions will vary in response to various data inputs.

6. The quality of particular types or masses of water must be appraised reliably. In lakes, distributions of physical and chemical properties are of paramount importance, especially during stratification periods. Success or failure of program design and goals depends on integrity and representativeness of data collected.

7. Since data is needed for short-term and long-term uses, program design and function must center around time-phased use of information. Rapid and reliable methods must be used, together with an interdisciplinary approach, to evaluate pertinent aspects of the physics, chemistry and biology of the system under study.

8. Numerous data collection and dissemination procedures now in use are archaic, slow and unresponsive to real needs. Automatic sampling, measurement and recording systems that reflect the many scientific advances of the past several decades should be used whenever practicable. The structure of a total field gear system -- composed of grab samplers, pump systems and _in situ_ electronic probes -- must be based on a clear understanding of data needs, strategy of implementation and control, and characteristics of the water to be managed.

9. Effects of the uncontrolled field environment require rigorous attention by the operator in the care and handling of his equipment. Applications will vary with type, location and objectives of measurements.

10. Water quality in a stream may vary with depth, streamflow and distance from shore. Considerable variations occur in lakes and impoundments from such causes as stratification, wind, rainfall and runoff. Field samples and data from different locations and depths, and at different times, may be necessary to characterize both streams and lakes.

11. To obtain real-time data for use in regulating projects or assessing impacts, electrophysical and electrochemical sensors can be used _in situ_ to determine distributions of various properties in water bodies of interest. Reliabilities of some of these for water quality applications have been demonstrated. Others are conditionally reliable, unacceptable, or being developed.

12. Use of such gear adds great flexibility to programs in that it gives investigators the ability to adjust field sampling procedures and formats to fit given situations. Results from _in situ_ probes can then be supplemented with results of information from grab or pump samples.

13. One special advantage of automated sample collection and data acquisition systems is cost-effectiveness. Manpower requirements are less, more data can be taken by fewer people, and personnel are released for other tasks.

14. Selection and procurement of appropriate field gear can be very easy or exceedingly difficult, and will reflect situations associated with particular studies and vendors. Although commonality of systems is desirable whenever possible, custom designs and construction will be necessary in some cases.

15. A proper and meaningful program is the very backbone of all analytical and interpretative work. Sample collection and data gathering in the field is the first in a series of steps that lead to the generation of final results.

16. Vital to any successful field program, in all phases of work, are proper quality assurance features. Satisfactory results are partly due to scientific knowledge, and partly art, but mostly are a matter of craftsmanship. Quality results will be lacking if no demands are made for first-class work.

17. The best approach to operation of field equipment is to use well-trained and informed operators who know the uses, functions and limitations of the equipment, and carefully maintain and calibrate it.

INTERAGENCY COORDINATION

By

Dr. Mark Anthony[1]

INTRODUCTION

The advantages and disadvantages of interagency coordination are discussed along with the kinds and levels of district and division activities that are required to fulfill various roles as participants. Various examples of ongoing coordination are described.

[1]Chief, Water Quality Section, Reservoir Control Center, Ohio River Division

INTERAGENCY COORDINATION

1. While the suggested title of this presentation was interagency cooperation, I prefer the more inclusive term "coordination." It is one of the most important activities that ORD is involved in. My intent is to provide a general academic dissection of this activity and to describe some of the ORD experience and ramifications thereof.

2. There are a long series of advantages and disadvantages involved in this process of coordination which must be anticipated by a manager. Some of these can be expressed by the following terms: time consuming--time saving; mandatory--nice to do; politically sensitive--politically safe; productive--wasteful; instructive--confusing; rewarding--embarrassing; and effective--ineffective. Positive considerations may include--avoid unnecessary controversy, reduce existing controversy, avoid or reduce duplication of effort, limit expenditure of effort, develop or enhance understanding, solve problems, improve agency response, and enhance resource management.

3. Coordination takes place within an umbrella of varying but often interlocking formats. For example, it may be formal or informal, one-time or continuing and may involve public hearings, committees, or groups. It may involve working level personnel or middle, upper, or top management representatives and mixtures thereof. It may be exclusive or inclusive regarding agencies, institutions, citizens, clubs, organizations, etc. The omnipresent news media is a factor to consider, especially in the formal format. Basic psychology plays a predominant role in these kinds of interactions.

4. All of the above factors and criteria help provide part of a conceptual sphere for both short and long range planning and implementation of coordination activities. The rest of this sphere is based on Federal environmental legislation and policy, project authorization, project operating purposes and impacts, Corps responsibilities and policies, and ORD water control missions and activities. In addition, specific, detailed water quality objectives occupy a prominent role in these considerations. We define our water quality responsibilities in the broadest possible ecological-basin wide terms (excluding the Tennessee basin).

5. ORD operates 70 storage reservoirs, most of which are multipurpose. Water quality problems are so extensive that only a few projects are relatively free of one or more concerns regarding environmental impact and related operating criteria. Most of our projects must be regulated on a day-to-day basis; reservoir and tailwater habitats are constantly changing. Combinations of water quality control and low flow augmentation demands in lower tributary and main stem reaches mandate systems regulation of reservoirs and coordination of some navigation structures. Each watershed, project and tailwater area may coincide with one or more

possible subjects for coordination. In addition, lower tributary and main stem Ohio River flows and the consequential impact on water quality-environmental relationships and navigation (including lower Mississippi River) benefits are entirely incidental to single project purposes. In other words, it was assumed early in the planning stage that if each project were operated effectively in maintaining tailwater conditions that the accumulative flows would maintain lower tributary and main stem flow conditions most of the time. Intensive local pressures to maintain recreational pools as late as December threaten the integrity of the ORD reservoir system and expand the dimensions, the complexity and importance of coordination activities by several orders of magnitude. This also dictates a need to monitor and coordinate district activities.

6. The water quality effort in ORD, including the districts, has become extensively involved in a series of cooperative-coordination activities. This is largely within the envelope of water resource management responsibilities and concerns, including our preimpoundment surveys. It is emphasized that this discussion is restricted to direct coordination by water quality-reservoir regulation elements and does not address such activity on the part of other Corps elements. We consider our coordination with other agencies to be so critical to water control procedures that a significant effort is dedicated to review-criticism and attempts to upgrade the activity.

7. The ORD water quality capability has been developed as a part of hydraulics and hydrology branches in the districts and the reservoir control center in the division. This has assured, to the maximum extent possible, absolute integration of most of the requisite quantitative and qualitative disciplines and skills and is the basis of our methodology, perspectives, and coordination. This teamwork approach has been liberally salted by the difficulty of learning to communicate across interdisciplinary lines and breaking down traditional Corps attitudes.

8. On a chronological basis, we attempt to initiate coordination with the state fisheries and stream pollution agencies when a preimpoundment study is started. Our approach is designed to get these people to work with us in a problem solving environment. We simply say "if this project is eventually constructed, it is Corps responsibility to assure the best possible environmental conditions, in and below the reservoir, that are consistent with resource management objectives. If you (the state) will help us, we will study alternatives and design a selective withdrawal capability that will potentially assure: (1) The best possible reservoir conditions relative to inflow waters; (2) The best possible discharge conditions relative to reservoir quality and resource management objectives; and (3) The most practical degree of operating flexibility in regard to future problems and/or changes in management priorities and objectives. Your participation in this regard will not be construed to represent individual or agency support of the project. In fact, we recognize that you (the state) may, as a part of this study, obtain information that might be useful in opposing eventual construction."

This approach has proven highly successful in: (1) Generating useful input from the state agencies; (2) Developing valid design and operating criteria; (3) Reducing controversy; and (4) Decreasing a credibility gap and improving subsequent cooperation. Initially, at least, this approach caused heartburn among some of our planners but it has not resulted in stopping a project.

9. When a project comes on line we attempt to maintain close coordination with these agencies in regard to verifying predicted conditions and peculiarities associated with fill. Subsequent experience or changing conditions may provide a basis for modification of operating criteria and so forth. What might be described as, more or less, routine coordination pertaining to older projects has become somewhat less complicated as the previously described credibility gap has diminished. However, considering the incredible number of variables associated with storage projects in ORD, any casual use of the expression "routine" is meaningless. Thus, as the district gains experience and knowledge regarding a specific project, major contacts and lines of communication for coordination should be pretty well jelled and enchanced by a history of mutual concerns and cooperation to solve problems.

10. One of the functions of the reservoir control center involves the Reservoir Operations Coordination Group which meets quarterly with interim communication as needed. Membership includes the governor's designated representative from each state in the basin, U.S. EPA, Coast Guard, Fish and Wildlife Service, Weather Service, Department of Agriculture, TVA, Federal Power Commission, ORSANCO (Ohio River Water Sanitation Commission), and ORBC (Ohio River Basin Commission). District participation is extensive and, depending on the agenda, working level representatives from any agency may participate or observe. This has been a significant springboard in terms of improving coordination-cooperation regarding water quality--fisheries--environmental type problems. A long series of specific problems have been identified, discussed, or resolved within this framework. It provides direct lines of communication to the hierarchy in the state and has helped cement working level relationships.

11. We also participate extensively, formally, and informally, in the ORSANCO activity. Many ORSANCO commissioners are the heads of state EPA or stream pollution control agencies plus Presidential appointed representatives from U.S. EPA, Corps, and Interior. A small professional ORSANCO staff is stationed in Cincinnati. There is extensive participation by industry, water users, citizens, and institutions. Primary responsibility involves water quality and pollution control on lower tributary and Ohio main stem reaches. A series of robot monitors bracket these reaches under direct management of the professional staff. Special surveillance and studies are usually contracted and much effort is aimed at coordinating the activities of each state and Federal agencies including the Corps. I have been extensively involved for several years on the ORSANCO Water Quality Monitoring Strategy Committee and a splinter

Biological Monitoring Group. Pittsburgh District has a separate contractual arrangement with ORSANCO regarding three robot monitors on the Allegheny River in addition to other funding from ORP, ORH, and ORL which subsidizes the main stem robot monitoring system. Otherwise, direct district participation is limited. The ORD water quality section acquires and interprets ORSANCO data to monitor low flow main stem conditions and provide guidance to the reservoir regulation section. ORP also utilizes data for the same purpose on the Allegheny and upper main stem. This coordinating activity provides a highly complex challenge. It seems sufficient to say that, with some overlap, lines of communications are separate from the Reservoir Operations Coordinating Group. Keep in mind, however, that the ORSANCO group is most concerned with the incidental benefits of the ORD reservoir system operation and is in an excellent position to criticize us while the former group is most concerned with the reservoirs and immediate downstream reaches.

12. Recognition that ORD had already instituted a significant level of coordination with the states in regard to reservoir water quality problems and needs for watershed controls prior to current Federal clean water legislation sets the scenario for the following discussion. Passage of the Clean Water Act led us to believe that additional resources might become available under certain sections, such as 208, for augmenting and improving our programs for meeting well identified objectives in an orderly, timely manner. Unfortunately, planning elements have perceived this to be a new problem and a new mission for the Corps. We are not doing a complete job in this regard, primarily because of district manpower limitations and priorities. Another constraint involves similar problems in state agencies.

13. In complying with direction from OCE we did meet with the appropriate state agencies shortly after passage of the Clean Water Act. Complete information was provided concerning Corps responsibilities and policies, our specific objectives, the details of our data collection program, and knowledge of problems and anticipated concerns. The state attitude was generally favorable at that time because of previous relationships. There was a sprinkling of animosity among the new cadre recruited to meet the expanded state responsibilities. However, there was willingness to share data and fully cooperate in attempting to control watershed pollution and meet state water quality standards in and below reservoirs. Because of the situation expressed previously, this cooperation has been spasmodic. I might point out that the impact of OCE's directive regarding this cooperation suggested reducing overall Corps' water quality data collection and costs. This somewhat shortsighted concept has been turned around but the ramifications linger in the field.

14. There is one exception that, in concept at least, is considered a classic example of optimal Corps-state cooperation. This came about in Kentucky as a spinoff of the ORSANCO strategy team effort. A key factor is the determination of the Kentucky stream pollution control agency to

fully harness all data collection to the awesome task of state water resource planning-management. This agency demanded the attendance of all Federal agencies (including ORH, ORL, and ORN) and state agencies with any environmental data collection activities and responsibilities at a meeting to organize the Kentucky Water Quality Monitoring Strategy Team. The context of Kentucky's preamble suggested throwing all data needs into a common hat and prorating the costs. This would have compromised Corps objectives, doubled or tripled district costs and otherwise been impossible. It required a lot more than diplomacy to turn this around. Had we failed to demonstrate an extensive, successful modeling capability, justify short and long range objectives, and defend the integrity of our water control program, a virtual impass might have resulted.

15. Eventually, a satisfactory compromise was worked out. The districts are responsible for monitoring reservoir conditions including inflow and discharge. The state and other agencies are responsible for watershed and downstream stations. The Corps retained some latitude in terms of flexibility such as changing sampling stations and frequency of data collection but the firm commitment to provide data, interpretation, and reports continues to exceed our capability. This should not be the case at all if the Corps had been more timely in meeting water control responsibilities. This would appear largely a question of priorities. As indicated previously, the framework for coordination with Kentucky is, conceptually, highly advantageous to the Corps, the state, and taxpayers. It ultimately promises major benefits for water resource management and is successful now in fighting "brushfires." To put this in perspective, a fraction of 1 percent of the annual flood control benefits recognized by Kentucky reservoirs would bring this coordinating effort up to speed.

16. I do not want to give the impression that we are complete failures because that is not the case. We are meeting about 80 percent of our obligations in data collection and interpretation. The basic problem really hinges on depicting and narrating what we know about the reservoirs. Our resource need involves development and implementation of fully automated procedures for interpreting, summarizing, depicting, and narrating changing reservoir conditions in 70 reservoirs in order to meet reservoir regulation requirements, state, and Corps needs.

17. We anticipated this impasse as early as 1970 and attempted then to get help. More recently our expressed concern with the status quo and utopian research ventures has become more succinct. An inordinate amount of money has already been utilized to support research programs for universities, AE's and Corps labs regarding the EIS requirement. In the meantime, reservoir regulation and hydrologic engineering priorities have been largely neglected for 20 years. A major redirection of forthcoming R&D money is justified in meeting Corps water control needs.

18. Now let me summarize. Coordination is a major activity and a most critical factor in the efficiency and effectiveness of the Corps water control mission. The engineering usefulness of the ORD water quality input is based first, on the absolute validity and completeness of detailed objectives, secondly, on absolute validity of data, and thirdly, on application of appropriate interpretive models. Ultimately, the integrity of our water control program is highly dependent on complete automation of essential environmental data (meteorological, hydrological, and water quality) interpretation, depiction and reporting procedures. There is no other recourse. If ORD had the requisite staff now, we might, with diligence, have our system on line by 1980. Unfortunately, the base level competence for requisite additional staff is not available--nor does it exist, except for a limited handful, within the fragmented Corps laboratory groups. Our aims fall short of optimal. They are consistent with a reasonable capability to respond and work with the states in planning and managing the water resources in our basin.

APPROACH TO A SUCCESSFUL WATER QUALITY STUDY IN RESERVOIRS

by

GERALD D. McKEE[1]

INTRODUCTION

Several water quality related types of studies are the responsibility of the Corps, such as monitoring drinking water and sewage discharges quality, determining the effect of dredging operations, assessing the impact of discharges for our permit activity, and determining the quality of the reservoir pool and the quality of the release from that project, this last area is emphasized in this paper.

It is required that both the reservoir waters and the release meet the minimum quality required for project purposes and state standards. The Corps should not only consider ways to meet minimum criteria, but should also consider ways to enhance the quality of the pool and/or the release waters. When investigating the operation of a project for water quality management purposes, it is essential that the short and long-term effects of this operation are known within reasonable limits. For example, a recommended operation of a project for a downstream objective should not be made without assessing the effects of this operation on the quality of the pool. When areas downstream of the immediate release are considered, it is often necessary to consider a systems operation. Some of the specific reservoir related water quality study objectives are:

a. To meet criteria and standards in operating projects.

b. Determining the effect of the reservoir on water in the pool, in the release, and farther downstream.

c. Making trend analysis for predicting future conditions.

d. Evaluating operations for the normal occurrences and also being prepared for a crisis situation, such as a spill above, in, or below a reservoir.

e. Establishing a data base to identify problems.

f. Collecting data to formulate and select a solution to an existing problem.

METHODOLOGY

The following is a general method that when followed should result in a successful water quality study for any of the purposes listed above.

a. The first step is to define the objective. The objective should be established by an interdisciplinary team and should be as

[1]Water Quality Section, Reservoir Control Center, Ohio River Division

specific as possible. "To assess the water quality in a project and its release" is too broad to be an obtainable objective. The term "water quality" is only meaningful in terms of specific parameters as they affect specific water uses. The objective should be written and expansion, reduction, or modification of the objective as the study progresses may be required. An initial objective may take the form: "To operate the reservoir to maintain desirable characteristics for a specific parameter in the pool and in the release." This objective must be refined to define desirable, which may have broader limits in some areas of the reservoir than in others. In order to operate the project for this objective, it is necessary to know the quality and quantity of inflow, determine where the inflow enters into the reservoir and the degree of mixing that occurs in the pool, assess what physical, chemical, and biological mechanisms occur to change this parameter, and from where in the pool the release is made. Mechanisms that occur after the water is released will also affect downstream uses. Therefore, this initial objective must be refined to:

(1) Characterize the parameter in the inflow;

(2) Determine how the parameter is affected in the pool; and

(3) Characterize parameter in the outflow.

b. The second step is to identify the parameters that are required to meet the objective. In some cases, the parameters to be measured are stated in the objective while in other studies, selection of the parameters is a complex step. The parameters initially selected for quantification should be prioritized based on their importance to the objective. This prioritizing is important because few studies can actually be implemented as initially conceived and establishing the relative importance of these parameters will enable the study team to make the study both efficient and complete.

c. Next, all of the factors that affect the concentration of these parameters must be identified. These factors include basin characteristics; annual, seasonal and daily variations; flow, chemical, physical, and biological reactions; pool morphology; hydrodynamics; and the zone of withdrawal. Each of these considerations should be compared to the objective to determine what additional parameters are required. Identifying these factors is usually the most time-consuming step in the planning stages and also the most important in terms of the detailed input by the interdisciplinary team. An example of the factors affecting a reasonably simple parameter are given in Table 1. Inspection of these factors with reference to the specific objectives will permit elimination of some of the factors. It should be noted that this listing expands rapidly in the areas that are expected to be important. For example, the items affecting just one of these factors such as bacterial decomposition include: algae growth, death and settling which are a function of temperature, light availability, nutrient concentrations and velocities, inflowing organic materials, suspension of benthic materials, and other items. Also, factors that are not expected to be important, can be

eliminated at this stage of the study. Atmospheric exchange, photosynthesis, and respiration are not expected to be significant in the hypolimnion of the reservoir and acid drainage may be non-existent in the particular basin under study and no further consideration of these should be made. This listing of factors will be similar for a given parameter for every study objective but the relative importance and the need to evaluate each will vary tremendously. The ability of the interdisciplinary team to focus on the important aspects of the study depends a great deal on the degree of completeness that is done in this step.

TABLE 1

Factors Affecting pH

A. Alkalinity

    1. Flow dependent

    2. Basin characteristics

B. Acidity

    1. Carbonic Acid

        a. Atmospheric exchange

        b. Biological reactions

            (1) Photosynthesis

            (2) Respiration

            (3) Bacterial decomposition

        c. Mineral acidity and alkalinity product

    2. Mineral Acid

        a. Excess over alkalinity

        b. Mine drainage

        c. Other industrial sources

C. Temperature

D. Dissolved solids

    1. Flow

    2. Basin characteristics

d. The next step is to select the locations of the sampling stations and establish the frequency that each location will be sampled. The information collected in the previous step is of paramount importance here, the tendency to sample every location for the same parameters on the same frequency must be avoided. When the detailed information developed in the last step is used to develop the sampling program, much more data useful to meet the objective can be obtained for the same costs. Another benefit is that the data base will not contain data that are not useful and may distract from the professionalism of the report.

For the example objectives in step a, at least three sampling locations are necessary, inflow(s), in the pool, and the outflow. The frequency of sampling required at each of these locations is highly location specific. Each significant inflow should be sampled, significance being determined by either quality or quantity, and the frequency should be based on the variability expected and not all inflows to the same project will require the same frequency of sampling. If power is a project purpose and there is no minimum release, sampling of the outflow is necessary only when a release is being made and sampling that discharge downstream to determine what happens to specific quality parameters will require a different frequency than quantifying that parameter in the outflow of a non-power project. An important consideration of inpool sampling is the velocity differences in both the vertical and horizontal directions. The velocities near the upper end of a reservoir will have velocities much greater than downstream areas and therefore a station near the upper end of the reservoir will have to be sampled many times the frequency of a station located near the dam to insure the material is identified as being in that segment. A high concentration of a material (slug) may take 30 days to travel from an inflow point to the discharge from the project under certain hydrologic conditions and sampling near the dam for this material during this 30-day period would be a wasteful expenditure of manpower and dollars. Also, not sampling the inflow on a freqently enough basis to identify this large concentration in the inflow can lead to difficult and costly sampling "chasing" a material in a project. After the optimum station locations are selected and the desired frequency of sampling at each of these locations are established, these optimum criteria must be meshed with existing manpower, dollars, equipment, and other restraints to establish a realistic sampling program to meet the objectives.

e. At this point, the characteristics that the data base will have are known. The number of values from specific locations for specific parameters has been established and it is now necessary to select the method(s) of analyzing and interpreting these data. It is important to decide what approach(s) will be used for analyzing the data prior to collecting the data for two very important reasons. First, the method(s) selected to analyze the data may require significant adjustment to the sampling program and secondly, a feedback mechanism from data analysis to the sampling location and frequency, should be established to insure that the objectives are being met and for efficiency. As an example, if there are mineral acid discharges in the basin that produce waters in

excess of the alkalinity containing waters, there are at least three separate conditions that will produce data requiring separate analysis. These conditions are: (1) background alkalinity conditions; (2) condition when alkalinity is significantly reduced but still present; and (3) condition when no alkalinity exists. By analyzing the data at set points during the study it may seem that all the data necessary to describe the first condition have been obtained; some, but not enough data have been obtained to meet the second condition; and no data were collected to describe the third condition. Therefore, the frequency of sampling may be adjusted at that point. The methods for analyzing the data and their criteria should be developed prior to the start of sampling and the data from the sampling effort should provide numerical values for these methods. Occasionally, modification of these original data analyses methods will be required during the study. Generally, this is a result of unexpected information and an excellent opportunity to gain knowledge about the project under study.

f. The next step is to identify the conclusions that will be possible from the analyzed data. These possible conclusions then must be compared to the studies objectives prior to embarking upon the study effort. Although this step might seem redundant, many apparently well planned studies flunk this test, the conclusions simply are not applicable to the objectives. Applying this test will prevent going full cycle in a study and realizing the objectives were not met.

g. The last step is to determine how the findings of the study are going to be presented in a report. The audience of the report must be considered with great concern and the report should be developed with the reader in mind. Some sections of the report should be written early in the study and a well written and designed report is suitable for a wide range of audiences. Separate reports for different audiences should be avoided whenever possible.

SUMMARY

Developing a well designed study presents something of a paradox: to sample correctly and efficiently, it is necessary to know what the data are before they are collected. Although this is impossible, the time spent developing a complete study plan and considering as many items as possible in detail prior to conducting the study will pay off many times the effort during the study and in the final product. The methodology presented in this paper when followed by an experienced interdisciplinary team will result in a cost effective, conclusive water quality study.

READING BIBLIOGRAPHY

1. Kittrell, F.W., "A Practical Guide to Water Quality Studies of Streams," U.S. Department of the Interior, Federal Water Pollution Control Administration; Cincinnati, Ohio; 1969.

2. Mackenthun, K.M., "The Practice of Water Pollution Biology," U.S. Department of the Interior, Federal Water Pollution Control Administration; Cincinnati, Ohio; 1969.

DATA INTERPRETATION FOR DESIGN OF SELECTIVE WITHDRAWAL STRUCTURES

BY

DARRELL G. FONTANE[1]

INTRODUCTION

The majority of Corps reservoirs experience some degree of thermal stratification on an annual cycle. Since the temperature of water is related to its density, thermally stratified reservoirs are also density stratified reservoirs. The mechanics of density stratified flow are such that for an outflow from a reservoir, the zone of withdrawal (the portion of the reservoir from which water is actually being withdrawn) and the distribution of flow within that zone is a function of the discharge rate and the reservoirs density stratification. This phenomena allows for a structure with various vertical outlet locations to selectively withdraw water with desired temperature or other quality constituents from a stratified reservoir. The purpose of this paper is to briefly discuss data interpretation for design of selective withdrawal structures.

The design of selective withdrawal structures is addressed by a recent engineering regulation, ER 1110-2-1402, 12 November 1976, "Hydrologic Investigation Requirements for Water Quality Control." This ER delineates specific hydrologic studies required for hydraulic design of selective withdrawal structures. These studies include the application of a temperature predictive model and analysis of the expected physical, chemical and biological characteristics of the impoundment and the downstream release. This paper will review the traditional manner in which these hydrologic studies have been accomplished with emphasis on their data interpretation aspects. The paper does not present the detailed information necessary to perform the actual data interpretation (a selected bibliography is included as a starting point for that purpose), but rather it discusses various data interpretation techniques generally employed and offers suggestions for their application. It should be noted from the outset that the techniques discussed will not all be appropriate or sufficient for all situations. While this paper only addresses hydrologic data, the design of a selective withdrawal structure involves other factors such as hydraulics, structural design, economics, operations, etc. and these factors should be considered concurrent with the hydrologic studies.

---

[1]Research Hydraulic Engineer, Reservoir Water Quality Branch, Structures Division, Hydraulics Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

DESIGN CONSIDERATIONS

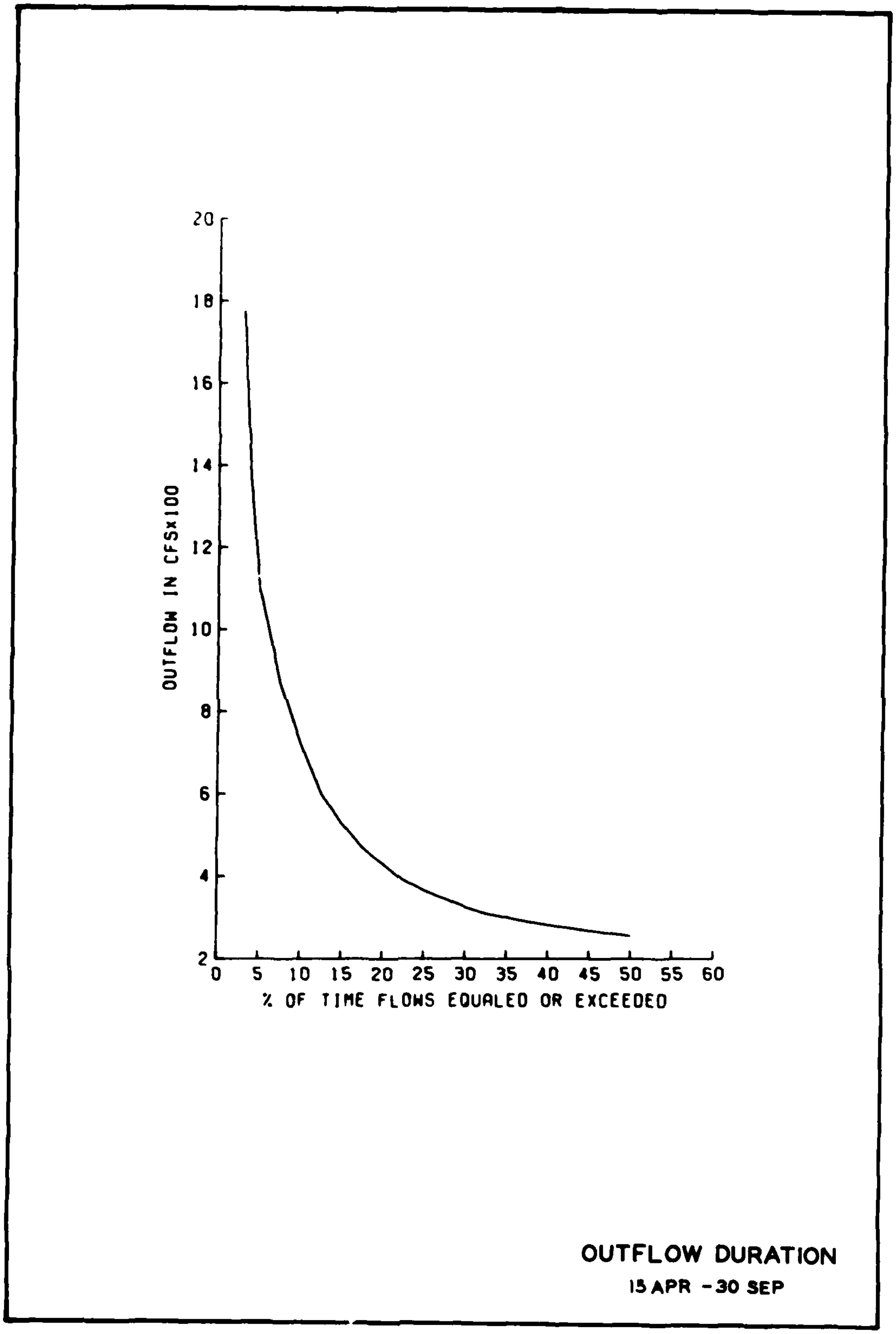
There are generally three design considerations of a selective withdrawal structure that must be addressed. These are (1) the type of structure, (2) the selective withdrawal capacity of the structure and (3) the number and location of ports within the structure.

Type of Structure

There are three general types of selective withdrawal structures. The appropriate type of structure for a given project depends on a number of considerations including reservoir size, degree of stratification, discharge rates, water quality objectives, the need for flow blending between withdrawal levels, project purposes, etc. The first type of structure is the single wetwell structure which consists of ports in a single well and a flood control passage. This type of structure is generally appropriate for shallow reservoirs with minimum stratification where single port operation is anticipated and blending between ports is not required. The second type is the dual wetwell structure which consists of ports in two wetwells and a flood control passage. This type of structure is generally appropriate for reservoirs expected to exhibit strong stratification where anticipated operations for water quality objectives indicates that the capability for blending between ports is desirable. In both the single and dual wetwell systems the selective withdrawal capacity is generally much less than the flood control capacity although possibly 40 to 70 percent of the downstream channel capacity. The third type of structure is one in which all discharges can be released from any selective withdrawal level. This type of structure is appropriate for hydropower operation when large flows must be released while maintaining a selective withdrawal capability.

Selective Withdrawal Capacity

Assuming that the type of structure selected is either the single or dual wetwell type, the selective withdrawal capacity of that structure must be determined. One manner in which this may be accomplished is to develop an outflow duration relationship as shown in Figure 1 for the planned project releases based upon daily routings for the period of record. Basically this consists of determining the frequency that a given flow will be equalled or exceeded. For example, from Figure 1, the exceedance frequencies for flows of 600 and 800 cfs are 13 percent and 9 percent of the time, respectively. Based on objectives and costs, a decision can be made whether the costs of increasing the selective withdrawal capacity from 600 to 800 cfs is "worth" the corresponding decrease (from 13 percent to 9 percent) in the exceedance frequency.



OUTFLOW IN CFSx100
20
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
35
40
45
50
55
60
% OF TIME FLOWS EQUALED OR EXCEEDED
OUTFLOW DURATION
15 APR - 30 SEP

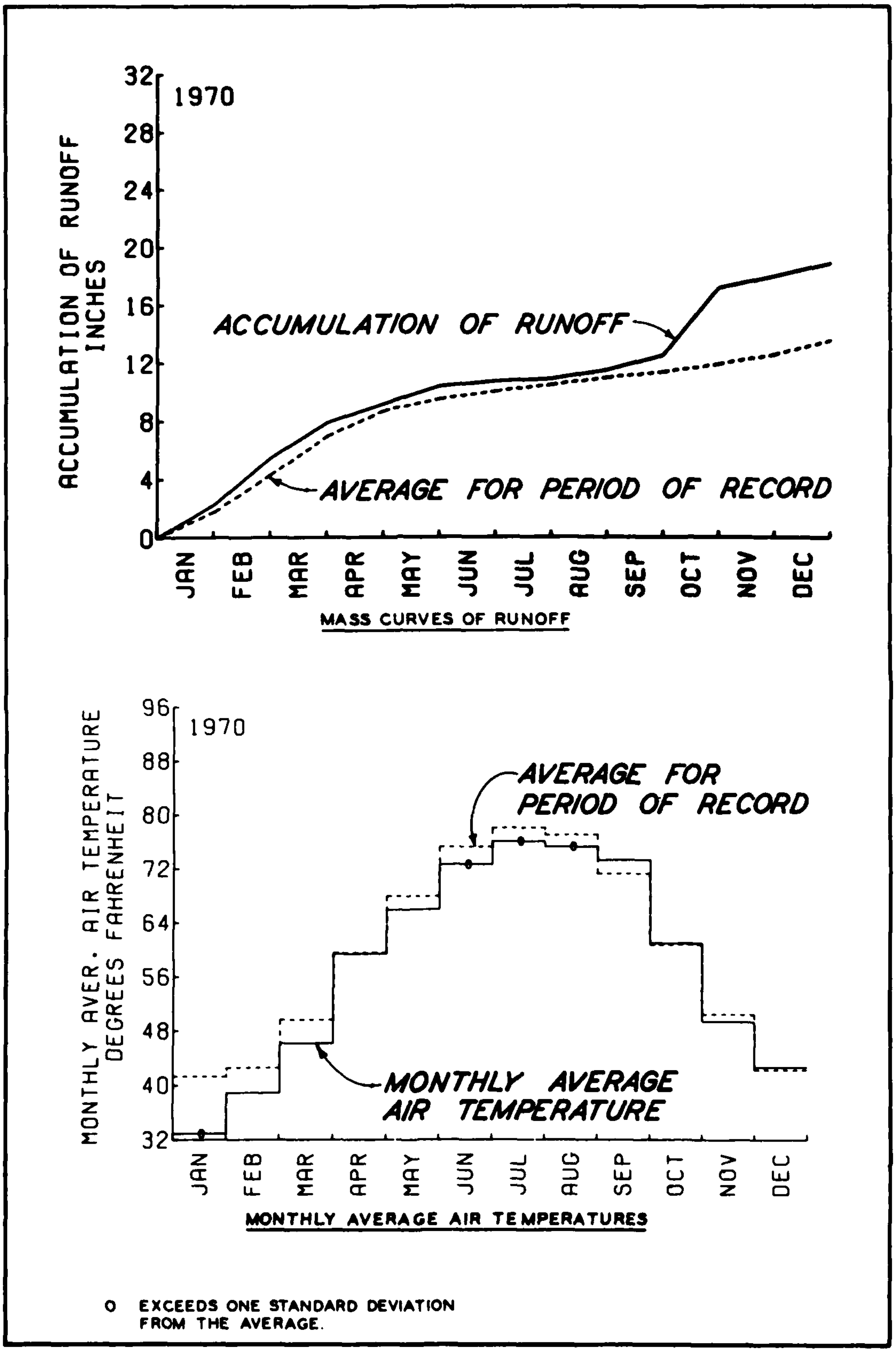
Figure 1

Although Figure 1 represents an outflow duration curve for the period 15 April to 30 September, shorter periods of analysis may be required based on the variability of the hydrology of the project. If a project experiences large spring runoff and a dry summer period, a seasonal approach will probably be required. During the spring, the project may not be sufficiently stratified to provide selective withdrawal; therefore, a large selective withdrawal capacity for that period would be unnecessary. That same capacity might then be much larger than required during the well stratified summer period. Only flows during a stratified period or season (this may involve thermal or chemical stratification or density stratification due to suspended solids) should be used for this analysis. Finally, the effect of blending flows between the selective withdrawal and flood control outlets on the release temperature should be considered in determining the selective withdrawal capacity.

Number and Location of Ports

The application of the temperature predictive model is normally the basis for selection of the number and location of ports within a selective withdrawal structure. Required data for the application of the temperature model include hydrologic routings, meteorological inputs, inflow stream temperatures and a release objective. Most commonly, historical data is used as an indication of the conditions to which the project will be subjected in the future. Additionall due to time and money limitations, the entire period of record is not simulated with the thermal model, rather a limited number of study years generally 3 to 7 years are selected. These study years are chosen to represent the range of conditions to which the project would have been exposed had it existed for the historical period of record. Combinations of dry, average, and wet hydrologic conditions and hot, average, and cold meteorologic conditions, such as dry-hot, average-average, and wet-cold years are selected. One method of analyzing the hydrologic and meteorologic data is to first compute the monthly means and standard deviations of runoff and dry bulb temperature for the period of record. Next the monthly average departures from those means values are tabulated for each of the years of record. Departures from the monthly mean that exceeded one standard deviation for that month are "flagged" to denote an extreme event. These tables are then used to select various conditions, i.e., hot, cold, dry, wet, etc. Additionally the tabulated values for each year can be plotted as mass curves of runoff and the monthly average value of the dry bulb temperature. By showing the average mass curve of runoff and temperature on these same plots, the various conditions (hot, cold, dry, wet, etc.) can be readily identified (see Figure 2).

It is extremely fortunate if inflow stream temperatures exist for the selected study years. Usually the inflow stream temperatures must



1970
ACCUMULATION OF RUNOFF INCHES
32
28
24
20
16
12
8
4
0
ACCUMULATION OF RUNOFF
AVERAGE FOR PERIOD OF RECORD
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
MASS CURVES OF RUNOFF
1970
MONTHLY AVER. AIR TEMPERATURE DEGREES FAHRENHEIT
96
88
80
72
64
56
48
40
32
AVERAGE FOR PERIOD OF RECORD
MONTHLY AVERAGE AIR TEMPERATURE
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
MONTHLY AVERAGE AIR TEMPERATURES
o EXCEEDS ONE STANDARD DEVIATION FROM THE AVERAGE.

Figure 2

be generated for the years of interest by statistical means. One method which has been used is to relate observed stream temperatures to meteorological conditions such as air or equilibrium temperature and flow using a multiple linear regression equation,

$$\theta_t = \beta_o + \beta_1 E_t + \beta_2 E_{t-1} + \beta_3 E_{t-2} + \beta_4 Q_t \qquad (1)$$

where

θ = stream temperature

t = Julian day

E = mean daily equilibrium temperature

Q = mean daily streamflow

β = regression coefficient

The form and application of eqn (1) depends upon the characteristics of the inflow stream. For heavily shaded streams, the use of air temperature in eqn (1) instead of equilibrium temperature may be more appropriate. Also, for streams effected by snowmelt, eqn (1) might have to be applied on a seasonal basis to yield satisfactory results. Once eqn (1) has been calibrated on the observed stream temperature record, it can be used to predict or generate the inflow stream temperatures for the desired study years. It is important to insure that the flows used in generating stream temperatures are within the same range as the flows used to calibrate eqn (1).

Release objective temperatures may be established by various means depending on project purposes. One common means is to use the pre-project natural stream temperature regime as a model for a release objective. For ease of project operation, the release objective should be a smooth function. A convenient mathematical technique is to fit a sine curve of the form,

$$\theta_t = A \sin (Bt + C) + D \qquad (2)$$

where

θ = stream temperature

t = Julian day

B = unit conversion from days to radians

A, C, D = regression coefficients

to the period of record and use that curve as a representation of the average natural stream temperature regime, see Figure 3. Additionally, sine curves may be fit to the maximum and minimum daily stream temperatures for the period of record to yield a band representing the range of natural stream temperature variations.

Once the study years have been selected, the inflow temperatures generated and a release objective developed, the simulations with the reservoir thermal model can be made. First, an initial structure design (number and location of ports) is selected. The number and spacing of ports required depends upon various factors including depth, degree of stratification, discharge rates, objectives, etc. Generally, an initial design with 5 ports, one in the epilimnion and 2 each in the metalimnion and hypolimnion is a good starting point. The project is then simulated for the selected study years. The predicted thermal profiles are analyzed (see Fig. 4) and the predicted release temperatures are compared with the objectives (see Fig. 5). The simulation results are analyzed to determine whether objectives can be met, what port operations were required, and what percentage of time the various ports were used. If objectives could not be met, additional ports may be needed, or conversely, some ports which were seldom or never used may be deleted and still allow the project to meet objectives. Based on this analysis modifications (if needed) are made to the initial design and the project is again simulated and the results analyzed. This procedure is repeated until either a satisfactory design is determined or it is found that objectives simply cannot be met. Finally, sensitivity analysis should be conducted to determine the affect of variations in the input data or model parameters on the simulation results and the selected structure design.

ADDITIONAL CONSIDERATIONS

Once a preliminary determination of the selective withdrawal capacity and number and location of ports has been made with the temperature model, the impact of other water quality parameters on that design should be assessed. At this point an interdisciplinary approach is highly recommended. Probably the most important aspect of withdrawal structure design with regard to water quality is flexibility. The structure should have sufficient capacity and port locations so that it can be operated to satisfy various water quality objectives and have the flexibility to handle unforeseen future requirements. With regard to most water quality parameters, the project will generally be operated to either retain the parameter within the reservoir or to release it downstream. As an example, consider a parameter such as suspended solids. Assuming that the suspended sediment was located primarily in the lower depths of the reservoir, the project might be operated to retain the material by releasing from high level ports or to flush the sediment downstream using low level ports. To accomplish

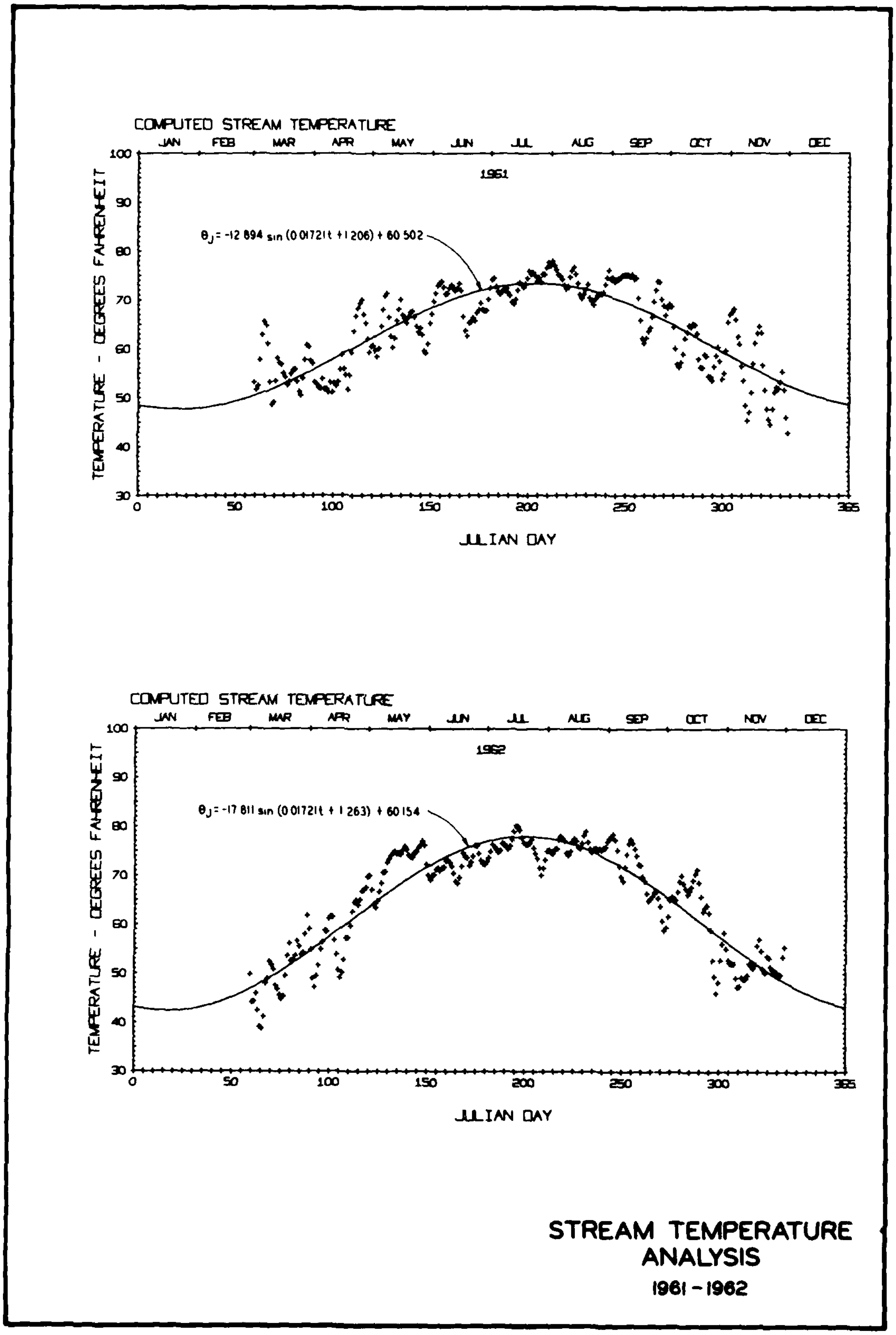

COMPUTED STREAM TEMPERATURE
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1961
θJ= -12 894 sin (0 01721t + 1 206) + 60 502
TEMPERATURE - DEGREES FAHRENHEIT
100 90 80 70 60 50 40 30
0 50 100 150 200 250 300 365
JULIAN DAY
COMPUTED STREAM TEMPERATURE
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1962
θJ= -17 811 sin (0 01721t + 1 263) + 60 154
TEMPERATURE - DEGREES FAHRENHEIT
100 90 80 70 60 50 40 30
0 50 100 150 200 250 300 365
JULIAN DAY
STREAM TEMPERATURE
ANALYSIS
1961 - 1962

Figure 3

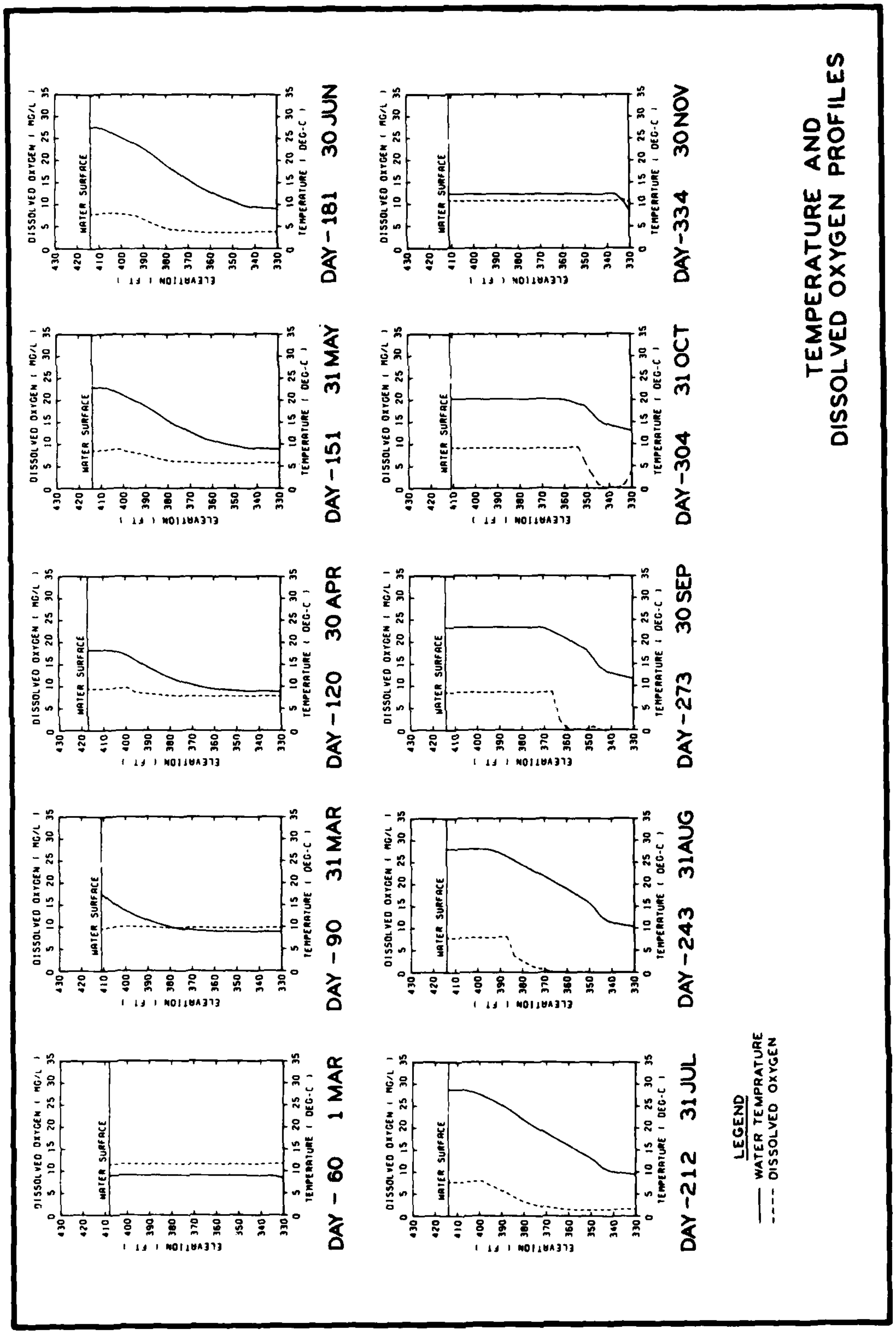
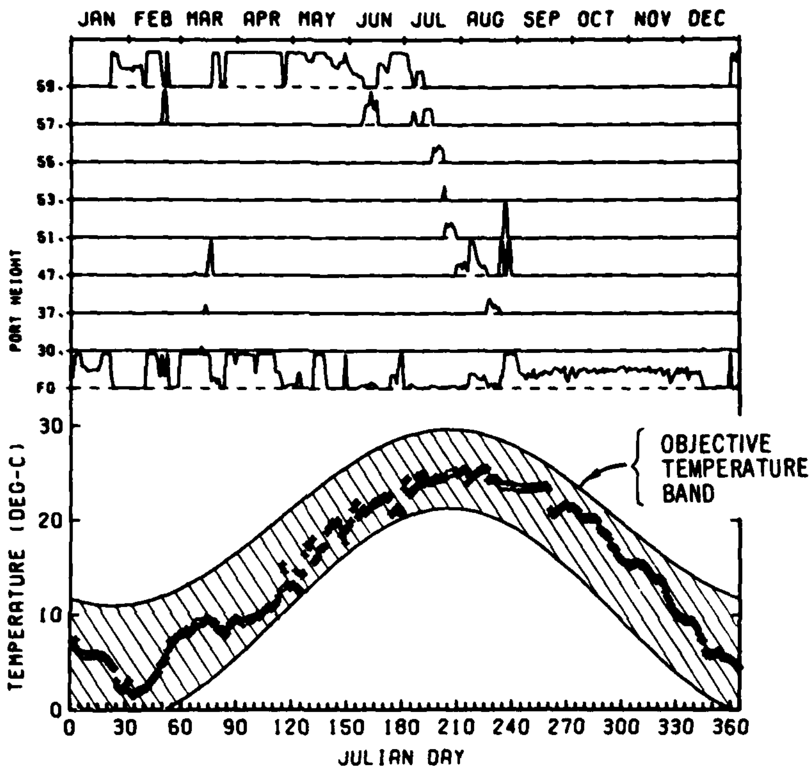

TEMPERATURE AND
DISSOLVED OXYGEN PROFILES
DAY - 60 1 MAR
DAY - 90 31 MAR
DAY - 120 30 APR
DAY - 151 31 MAY
DAY - 181 30 JUN
DAY - 212 31 JUL
DAY - 243 31 AUG
DAY - 273 30 SEP
DAY - 304 31 OCT
DAY - 334 30 NOV
DISSOLVED OXYGEN (MG/L)
TEMPERATURE (DEG-C)
ELEVATION (FT)
WATER SURFACE
LEGEND
WATER TEMPRATURE
DISSOLVED OXYGEN

Figure 4



COMPUTED RELEASE TEMPERATURE

OBJECTIVE TEMPERATURE RELEASE

Figure 5

these operations, the structure would require both high and low level ports. The need for these ports may or may not have been identified during the initial study with the temperature model.

To evaluate the capability of a withdrawal structure to satisfy water quality objectives, an estimate of the vertical distribution of the water quality parameters immediately upstream of the structure must be made. A water quality predictive model might be used for this purpose. Whether a predictive model or other means are used to predict the water quality parameter profiles at the dam, it is essential that the effects of reservoir hydrodynamics, including inflow mixing, travel time of density currents and wind mixing, on those water quality parameters be understood.

Additionally, any effect of the outlet works on the water quality of the release flow should also be considered in determining the ability of a project to satisfy release objectives. Flow passing through flood control outlet works can experience considerable reaeration and the DO content of the release can be substantially increased over the DO content of the flow entering the outlet works. If the release flow still has a high oxygen demand, however, a decrease in DO could be experienced downstream.

A similar evaluation procedure to that used with the temperature predictive model can be used for other water quality parameters. An initial design (the one developed considered temperature only) is selected, the project is simulated (assuming a water quality predictive model is used), and profiles and release qualities are compared to objectives. Modifications, if appropriate, are made and the procedure is repeated.

Finally, the design which has been selected based on the temeprature and other water quality objectives should be reevaluated from an operational viewpoint. The results of the thermal and other water quality parameter simulations indicate the type of regulation that will be required to meet objectives. This regulation should be one that is practical to achieve and commensurate with other project purposes.

SUMMARY

This paper has discussed in general terms some available techniques for interpreting data used in the conduct of hydrologic studies for selective withdrawal structure design. Again, the interested reader is directed to the selected bibliography as a starting point for more detailed information on the techniques discussed in the paper. The techniques discussed were those which most commonly have been used in the past. As future selective withdrawal projects are faced with satisfying a greater variety of objectives, the analysis of those projects will become increasingly more complex. For that situation, the potential for the development or application of a multitude of data interpretation techniques is unlimited.

SELECTED BIBLIOGRAPHY

1. Engineering Regulation No. 1110-2-1402, 12 November 1976, "Hydrologic Investigation Requirements for Water Quality Control," Department of the Army, Office of the Chief of Engineers, Washington, D. C.

2. Bohan, J. P. and Grace, J. L., Jr., "Selective Withdrawal from Man-Made Lakes; Hydraulic Laboratory Investigation," Technical Report H-73-4, Mar 1973, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS.

3. Edinger, J. E., Brady, D. K., and Geyer, J. C., "Heat Exchange and Transport in the Environment," Report No. 14, Nov 1974, Electric Power Research Institute, Palo Alto, CA.

4. Dortch, M. S., Loftis, B., Fontane, D. G., and Wilhelms, S. C., "Dickey-Lincoln School Lakes Hydrothermal Model Study," Technical Report H-76-22, December 1976, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS.

5. Drummond, G. R., and Robey, D. L., "Heat Budget Analysis and Development of Design Criteria for Selective Withdrawal Outlets, Taylorsville Lake, KY," Special Report No. 2, U. S. Army Engineer Division, Ohio River, Cincinnati, OH, April 1972.

6. Drummond, G. R., and Robey, D. L., "Heat Budget Analysis and Development of Design Criteria for Selective Withdrawal Outlets, Yatesville Lake, KY," Special Report No. 7, U. S. Army Engineer Division, Ohio River, Cincinnati, OH, February 1974.

7. Drummond, G. R., and Robey, D. L., "Natural Stream Temperature Analysis, Allegheny River Near Kinzua, Pennsylvania," Special Report No. 8, U. S. Army Engineer Division, Ohio River, Cincinnati, OH, February 1975.

8. Loftis, B., and Fontane, D. G., "Falls Lake Water-Quality Study; Hydraulic Laboratory Investigation," Miscellaneous Paper H-76-6, Apr 1976, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS.

9. Loftis, B., Saunders, P. E., and Grace, J. L., Jr., "B. Everett Jordan Lake Water-Quality Study," Technical Report H-76-3, Feb 1976, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS.

10. Wilhelms, S. C., "Bay Springs Lake Water-Quality Study," Technical Report H-76-7, May 1976, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS.

CONTRACTING FOR WATER QUALITY DATA

Robert M. Engler
Environmental Effects Laboratory
Waterways Experiment Station

With the advent of numerous comprehensive environmental programs by the Corps of Engineers and due to severe personnel limitations, the Corps Districts, Divisions, and research facilities are required to contract for a significant amount of the required ecological data. Presented in this lecture is a basic, although somewhat idealized, contracting protocol that can be used for a civil works or military activity requiring environmental monitoring and assessment, e.g., dredging, filling, reservoir activity, etc., where water quality is an overriding consideration. All contractual matters should, however, be cleared through the appropriate contract and legal offices.

Pursuant to Public Laws 92-500 and 92-532, water quality by definition is the major environmental concern as it impacts human health and amenities. Consequently, the definition of water quality is very comprehensive and is not simply a water column chemical parameter but how various Corps activities effects the ecosystem. The environmental investigations then have to be designed and built around these very broad and general objectives, and presented herein are basic methodologies to consider in contracting a water quality investigation. These suggested procedures may be useful for collection of chemical, biological, or physical data, or any combination thereof. It is important to note that this is not a discussion of AE or R&D contracting procedures nor is it a discussion of Army procurement regulations. Each CE District, Division, and research facility conducts its contract procedures; consequently, the following procedure may be modified to fit a specific need. Presented in Appendix A are copies of the slides used in the lecture.

Initially, and of greatest importance whatever the project under consideration, there should be very clear and concise project objectives and a clear description of the research approach. This is especially true for water quality investigations where the area of investigation is sufficiently broad that a contractor must have the contract limits well defined to accomplish the goals. After problem identification the initial scope of work must be well written and clearly define the subject area and must be perfectly clear both as to concept and initiation as well as finalization of the work at hand. There are several questions, however, that must be asked prior to preparation of the scope: Why is the work being done? What exactly is going to be done? How are the data to be used, interpreted? Is this simply a baseline study where no data have ever been collected or is this a tertiary study to add to a previously conducted baseline? What will be the tangible products of this work? There may well be other site specific questions.

Review of past environmental contracting efforts have shown that these important questions have not been asked in every case and in such cases many government programs have needlessly invested a lot of time contracting water quality information. Contracting is not the best way to get the job done, but with the manpower restrictions and increasing work loads it is fast becoming a primary method of work accomplishment. Consequently, when a contract is let, careful management is mandatory.

Preliminary to any schedule event in a project, including the writing of the scope of work, a rigid milestone schedule must be constructed and adhered to throughout the entire investigation or data gathering exercise. An example of a typical milestone schedule is presented on Slide 4 of Appendix A (slides presented at workshop) for four projected projects. Presented are a sole source procurement and three competitive procurements. Consider the first project of the four presented and go through the various milestones that should be met in producing what will hopefully be an acceptable final product. The final product must answer pertinent questions and meet the highest of scientific and engineering standards. Important steps to follow are the scope of work preparation, in-house review of scope of work, preparation of the Request for Proposals (RFP) or Request for Quote (RFQ). This is followed by an advertisement period with an evaluation of the proposals received. Negotiations are then conducted with one or more of the respondents. This is followed by an evaluation of the negotiated proposals followed by contract award. At this point, about one-fourth of the procedure is complete. Remaining is the critical part, contract management. For sole source procurement, a similar procedure without advertisement is followed although it may require a little less time.

At this point, it is important to discuss each one of the procurement steps in sequence and present some basic facts on "do's" and "don't's" for each of the previous steps.

Scope of Work Preparation. Presented as Appendix B is a sample scope of work for a comprehensive field study conducted as part of the Dredged Material Research Program. This sample scope of work has most of the characteristics required for contract procurement of water quality data. Also presented are some basic, although somewhat general, ideas of the type and breadth of information needed for a scope of work. Included are the considerations involved in evaluating the respondent to the advertisement. Following the scope of work preparation a review of legal counsel and contracts personnel is required prior to advertisement and a further review by the District. The following general comments are summarized on Slides 5 and 6 of Appendix A. Generally, the scope of work must clearly demonstrate the background leading up to the project and the relationship of the project of concern to other projects. Prospective respondents to the scope of work must know why they are conducting the work and they must depict its relationship to other projects. The objective of the project must be clearly defined and the research approach must be clearly described to the prospective contractors. This is especially important when a baseline field investigation is proposed and consists of procedures

that require state-of-the-art practices and will be conducted routinely to result in reliable and accurate information. It must be clear how the data are to be presented and discussed and must include relevant information such as other on-going projects that may impact the proposed project. Information specifically needed for a scope of work may include on-site field data that will be related to the laboratory analyses, such as water column temperature, hydrodynamic data, climatological data, the exact number of samples to be collected and the precise location of sampling stations. The previously presented points are important in contract cost estimations for a government estimate prior to advertisement. They are also important for conducting negotiations with a prospective contractor.

Another item that may be included in the scope may be a specific procedure for sampling to include an experiment design; however, this may be deleted so the prospective contractor can be more closely evaluated on this important point. On the other hand, it may be necessary to thoroughly describe the experimental design. These very specific points are needed because we use contracts as though they were an in-house effort or just as though one of your own staff were conducting the study. The prospective contractor should be told exactly what is needed, how it should be done, and when it should be done. Other points should include sample preservation and transportation as these can most significantly impact water quality work. The collection of organisms, water column samples, sediments, etc., if done improperly can invalidate an entire study. Clearly describe the various parameters of interest because the prospective contractor must know these for his costing purposes. Prices for just an analytical evaluation of various parameters runs the cost for a few dollars per sample to several hundred per sample. Consequently, this can be most important in costing out the particular contract and is usually a major contribution to the total cost. Analytical methods and quality assurance programs must also be described since it is almost always necessary to use the same analytical procedures for data to be compatible with previous work or work of others or for a baseline investigation that will produce accurate as well as precise data. Quality assurance programs are needed for accurate, precise and reproducible data whether it be water column chemical parameters or organism body burden analysis. The entire program can rest just on this one item.

Data presentation must also be described such as the types of graphs, charts, tables, etc., that are required. Guidance on data evaluation must also be presented. It may be desired that the groups responding to an advertisement suggest statistical plans for further evaluation of expertise. It must also be decided prior to advertisement what type of data interpretation is required of the contractor. It may be necessary to conduct all data evaluation or interpretation at the District and Division. However, if additional interpretation by the contractor is needed be sure to include that point. Lastly, precise milestone schedules should be adhered to by the contractor and should be included as part of the scope.

Because most CE projects are conducted around tight budgetary and time constraints, and if the water quality data collection is related to ongoing construction activities, these activities must be considered in program planning. The scope must include a reporting schedule (monthly, interim, final) and carry realistic dates of completion. Structure of the final report is another important aspect and the scope should include as much detail as possible on this point. All of these points have input in the final cost of the contract and every portion added after the contract through modification may cost much more.

After completion of the scope of work, an in-house review of the scope is then required. Consequently, it may be necessary to use independent consultants for review. It may also be necessary to check with the District legal counsel concerning the use of consultants on an advertised request for proposals. The consultant could easily be from another agency and not have to be a private consultant. A multidisciplinary in-house review committee must also be appointed and guide the review of the scope. As an example, a civil engineer should not be expected to review in detail biological and chemical sampling procedures and on the other hand, a biologist should not be the only reviewer on projects involving hydrodynamic considerations. A multidisciplinary team should be involved in most water quality investigations. Consultants may be used in place of in-house expertise if it is not available. You cannot necessarily rely on the contractor to fill the expertise gap at this stage.

In preparing a RFP or sole source memorandum, all of the points raised in the previous parts of this paper relate to a competitive procurement as well as a sole source procurement. These points also relate directly to an interagency procurement which was discussed in an earlier lecture. In preparing the final RFP and after consideration of review comments, a legal review of the procurement is required and may cause some time delays. In deciding final procurement process, consideration is then given to a sole source or competitive procurement. The competitive procurement is the best way to go, and sole source procurement should be chosen when only one source is available. An example of sole source is where an uncommon or unique expertise is needed and cannot be obtained by competition. For broad ecological studies, however, a much better sampling of expertise can be obtained by a competitive procurement.

In the actual RFP it may be necessary to list all of the requirements presented previously or it may be desired to leave out a specific requirement simply to form a base from which to evaluate the received proposals. However, when a sole source procurement is used only one proposal is being evaluated and all of the conditions and details should be given as it is going to be part of the contract.

A few additional suggestions--do not rely heavily on sole source procurement and do not necessarily concentrate on local expertise or a big name or prestigious principal investigator. A big name may be well received

but he may not respond in areas of a broad study and on the other hand he may well do an outstanding job. These are just a few aspects to consider in a procurement procedure. The RFP or RFQ route should be used as much as possible and produces a much broader sampling of expertise on selection of contractors from a large diverse group. This broad selection eases the task of evaluating all areas of expertise.

When using the RFP route, 20 to 30 responses may be normal, and it would take several weeks to critically evaluate these responses. Consequently, the more detail included in the scope, the more likely the respondents to the advertisements will repeat the information in their proposals without creatively providing answers to the problem. This will result in a lot of reading between the lines during review of the proposals Once the advertisement is completed, review of the proposals should then be conducted by a multidisciplinary technical review committee, preferably the same committee that initially constructed the scope of work. The committee should then conduct an independent and separate review of each proposal. The committee should then meet as a panel to discuss deficiencies and select the most significant responses comprising a competitive range for negotiation. The top proposal may be picked, however, and negotiated with if all other responses cannot be brought to that same level through negotiation. It may depend on the respective District legal and contract review procedures as to how many respondents must be negotiated with.

In review of these proposals there are several important points to consider. Don't necessarily concentrate on local expertise or big name. Local expertise has its advantages particularly in mobilization to the field and subsequent cost of mobilization. This is important if a significant number of sample boats and personnel are required. As an example, if the job is being done in Lake Erie and the respondent is from San Francisco, it may cost significantly more to mobilize from afar rather than those on Lake Erie. There are advantages to local expertise but it may not produce necessarily the best product. Ensure that the individuals responding have all the necessary equipment to meet objectives and goals. Examples of these needs are the required vessels, and navigational positioning systems (necessary for returning to original sample site) a thing as simple as inadequate navigational systems can negate an entire study whether in a reservoir, watershed, river system, or a lake. Consider the cost of sampling and analysis per parameter and sample because of its importance in subsequent cost negotiations. The costs of these analyses can be monumental, as an example, a reasonable cost for PCB analysis on one sample varies from \$50 to \$100. If there are 40 sampling stations, 4 reps per station, 6 samples per profile, it becomes apparent that a lot of expense can be tied up in any one parameter. Consequently, it is important to estimate costs on a per parameter basis. This is most important in conducting water quality investigations negotiations because very stringent water quality criteria may have to be met. Analytical work will be conducted at very low levels of parameter detectability and will subsequently increase the price of these various parameters.

It is necessary to review closely the expertise of contractor personnel in relation to the scope of work, and the number of manhours devoted to each person. It is important to know how many hours the contracted personnel are putting into the specific project and also how many hours the technicians and graduate students are putting in. The technicians' time is important but for contracting the expertise needed on a project, it is necessary to know how much time is being put in by the high level personnel.

The respondent to the RFP should maintain very closely the milestone schedule suggested in the scope, and if this schedule is not maintained it should be explained as to why not. If the respondent wants to deviate from the methodology suggested in the scope of work, he should then come in with good reasons for the change. If additional expertise is needed to evaluate the proposed changes, consultant help may be needed. Examine closely any changes recommended by the prospective contractor, because it may be impractical or invalidate the project.

For comprehensive ecological studies, it may be necessary to have one contractor that could subcontract the various physical, chemical, and biological portions of the study. However, this procedure often has severe problems. Often it is time consuming to coordinate several independent contractors on one study, and if it is necessary to go to one then the subcontractors must supply the appropriate expertise and methodology. From a management standpoint, it is a lot simpler if several contractors are required to write this into the scope of work. Consequently, coordination between contractors and subcontractors will then be part of the contract.

It is necessary to negotiate and reevaluate the top proposals and to overcome deficiencies in the responses, reduce costs, explain key points in their response in greater detail, and to determine the most responsive prospect by clarifying very fine points in respective proposals. It then may be necessary to renegotiate and the negotiation points must be clear, concise, and structured to theoretically bring each negotiated respondent to the same level.

At this point an award has been made on the contract and it must be emphasized that the length of time it takes to reach this point is often four to six months from start. This time requirement must be entered into the initial conceptualization and milestone schedule of the project. Project (that project being evaluated) lead time is obviously important and it is necessary that the required starting date should be four to six months after initiation of procurement. It is also necessary to consider contractor mobilization in all plans. The contractor may have to mobilize on the date the contract starts or it may take him until twelve months afterwards. This is very important since the construction activity (project) undergoing evaluation may not wait for contract mobilization.

Other District offices and projects that impact this study must be considered in the planning and intra-District coordination is necessary. It is important that coordination with the District or Division be done. In summary, it is necessary to consider coordination on all phases among these offices, other contractors, and other impacted agencies.

Probably 10% of the problem has been overcome at this point. Contract management now follows and is absolutely the most important phase of the project. Poor management of the contracts can invalidate the entire study. Some general contract management considerations follow: It is important to assign a manager to each contract; however, due to manpower restrictions this may be impossible and several contracts may be handled by one manager. The manager selected for the specific contract(s) should be involved in all of the developmental stages of the scope of work and throughout the remaining procedures. The manager's expertise should be directly related to at least some important phase of the contract. He subsequently has to know, from a technical point of view just what the contractor is doing at all times. For a multidisciplinary contract, consultants or secondary managers may be used; it is important, however, to have one key individual to monitor the work. It is hard to estimate the exact number of manhours that should be used for contract management, but to do it right it will take 20-30% of his time. This requirement will, however, fluctuate depending on if the contractors are in the field, in the laboratory gearing up, interpreting or whatever. The manager must also be able to deal with the contractor on a mutual, professional level with regard to technical matters.

Some specific considerations in contract management are: If the contractor has some suggestions, respond appropriately or obtain necessary consultive help and get back to him as soon as possible. Allow no deviations from the contract schedule unless it is absolutely necessary to change the schedule. Never become personally involved with the contractor. Expect surprises throughout the contract but be prepared to respond to these surprises. Never assume anything is going right in the contract; know what is going on and especially know if the contractor is adhering to the contract. It is necessary to monitor all aspects of the contract and personally participate in all field operations. When the contractors are out in the field collecting data, it is important to be there with them, and determine what they are doing. It may not be necessary to be there all the time - surprise them and come out in the field or show up in the laboratory. It is necessary to conduct sample cross-checking or splitting or to bring consultants to help if the District expertise is limited. It is necessary to regularly count heads, make sure the people contracted are doing the work. It may even be necessary to go TDY to field locations for extended times. It is important to hold frequent contractor meetings and require this in the contract. Holding mid-contract workshops and summary meetings will be most helpful in meeting contract goals. Detailed planning sessions and field coordination sessions should be held prior to any field operation; never assume that the contractor knows every aspect of the proposed field work.

Require a minimum of monthly progress and data reports as it is important to see the data as it is generated. Require an interim report that will be structured similarly to the final report so that it can be given a good review. Find the mistakes that may have been made and see that the final report does not repeat them. Lastly, make sure the scope of work is being met on all aspects. If it is not being met, it is important to determine why it is not being met. The final report must have an appropriate, critical, and technical review.

In summary, contract management must be active rather than passive and it will not be easy. The previous discussion has been an idealized approach at contracting ecological data. The approach may have to be modified for specific projects or unique District and Division procedures, and whether going sole source, advertised or interagency procurement, the same procedures should follow.

APPENDIX A

Slides Used in Workshop

SLIDE 1

Contracting for Water Quality Data

SLIDE 2

PRELIMINARY

- Not a presentation or discusstion or AE or R&D contracting procedures nor a discussion of procurement regulations.
- Objectives and approach of the contract work must be well defined prior to development of a scope of work or any detailed planning.

It must be clear.

- Why the work is being done.
- What is going to be done.
- How the data are to be used.
- What will be the tangible products.

SLIDE 3

PRELIMINARY (cont)

- A milestone schedule must be constructed and adhered to.

SLIDE 4

See attached table.

SLIDE 5

SCOPE OF WORK PREPARATION
(GENERAL)

- Must clearly demonstrate:
  - Background leading up to the project and relationship to other projects.
  - Objectives of study.
  - Research approach and procedures.
  - How the data are to be presented and handled.
  - Other relevant information that may be important to the prospective contractor.

SLIDE 6

SCOPE OF WORK PREPARATION (cont)
(SPECIFIC)

- Additional on-site data to be taken in relation to laboratory analyses.
- Exact number of samples and stations and station location, if possible.

- Sampling procedures and experimental design.
- Sample preservation and transportation.
- Sample preparation procedures.
- Parameters of interest.
- Analytical methods.
- Quality assurance programs.
- Data presentation.
- Data evaluation (statistics).
- Data interpretation.
- Precise milestone schedule.
- Reporting schedules monthly, interim, final.
- Structure of final report.
- As much detail as possible.

SLIDE 7 — In-House Review

- Consultants should be used if expertise not available in District.
- In-house review committee should be appointed especially for a multidisciplinary project.

SLIDE 8 — PREPARE RFP OR SOLE SOURCE MEMO

- Consider review comments.
- Legal review.
- Final rewrite.

SLIDE 9 — PROCUREMENT

- Competitive. You may want to list all of the requirements previously listed or leave out certain pertinent information so to have specific points from which to review and evaluate the proposals.

- Sole Source. You must list all qualifying information so to insure that all points are considered in the contract.

SLIDE 10 — SUGGESTIONS

- Do not rely heavily on sole source contracting procedures entirely or concentrate on local expertise or "big named principal investigators.'
- Should as much as possible use the RFQ or, even better, the RFP route to enable a broader sampling of expertise or selection of contractor from diverse group of respondents.

SLIDE 11 PROPOSAL REVIEW & EVALUATION

- Should have a technical review committee of at least three people.
- Conduct an independent review as quickly as possible.
- After review, meet as a panel to discuss deficiencies and select top two or three to negotiate for a final product.

SLIDES 12 & 13 POINTS TO CONSIDER IN REVIEW

- Do not concentrate on "local" expertise for a "big name" principal investigator. There are advantages to local expertise but may not produce best product.
- Make sure respondent understands and considers objectives, scope, and all pertinent aspects of the RFP.
- Make sure respondent has necessary vessels, positioning systems, personnel, etc.
- Consider cost of sampling and analysis per parameter and sample; important in negotiations and/or contract modifications.
- Prestige of the principal investigator or institution should not be a major factor. Often a less prestigious contractor or smaller company can furnish superior data and be easier to deal with; although, may be less capable of interpretation.
- Review closely the expertise of personnel in relation to scope of of work and man hours put in by each person.
- Respondent should maintain closely the milestone schedules or clearly explain why they cannot be adhered to.
- Respondent should clearly explain deviations from scope of work and present benefits of the change.
- Try to get one contractor to do entire study; if necessary, primary contractor should subcontract. It is extremely hard and time consuming to coordinate several primary contractors conducting one study.
- If several contractors are needed, coordination must be part of of the contract.

SLIDE 14 NEGOTIATIONS AND RE-EVALUATION

- To overcome deficiencies
- To reduce costs.
- To explain key points in much greater detail.
- To determine most responsive prospect by clarifying fine points.
- Negotiation points should be:
  - Clear.
  - Concise.
  - Be structured to theoretically bring each respondent being negotiated with up to the same level.

SLIDE 15 AWARD

- It cannot be overemphasized that it takes at least 4 to 6 months to reach this point; consequently, the following points should be considered:

  - Project lead time is important.
  - Consider required starting date and allow 4-6 months lead time.
  - Consider District projects (construction, dredge, fill, etc.) in meeting award date.
  - Insure coordination among District offices, other contracts, and WQ contractor.

SLIDE 16 CONTRACT MANAGEMENT

- The most important phase of the operation.
- Poor management can negate any well planned investigation.

SLIDE 17 MANAGEMENT CONSIDERATIONS

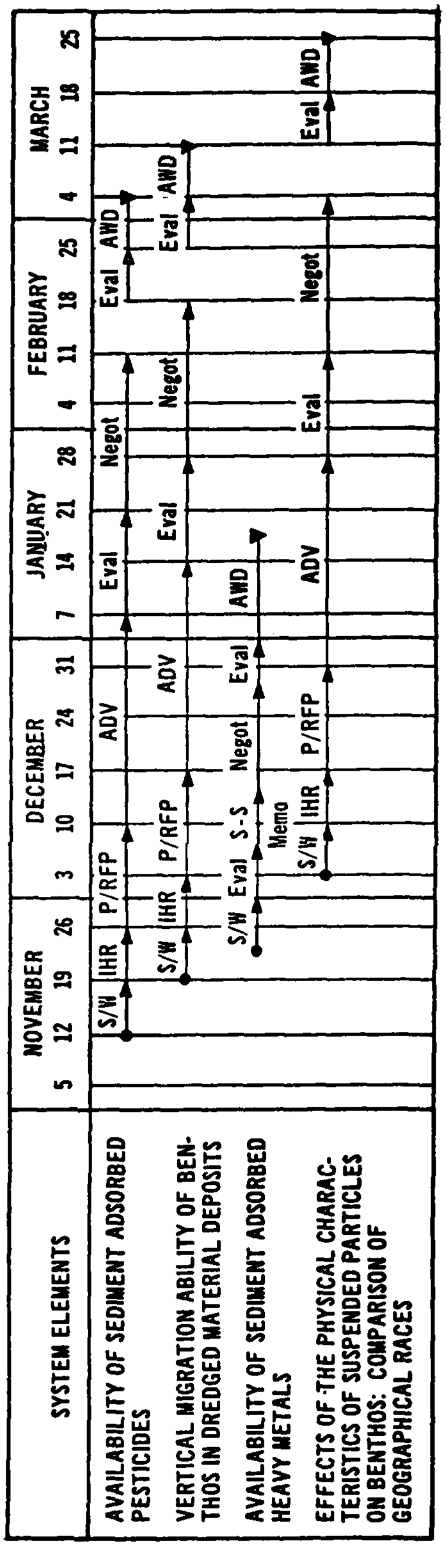
- Assign one manager to each contract.
- Manager should have been involved with all development stages of scope of work or have been on review committee.
- Managers' expertise should be directly related to contract.
- For multidisciplinary contract, consultants or secondary managers may be necessary.
- Manager must be able to deal with contractor on a mutual professional level with regard to technical matters.

SLIDE 18 IN MANAGING

- Allow no deviation from schedule, if at all possible.
- Never let the contractor dictate -- if in doubt get competent consultative help.
- Never become personally involved with the contractor, otherwise judgment may become clouded.
- Expect surprises, but be prepared to respond quickly and with authority.
- Never assume anthing, especially that the contractor is adhering to the contract.
- Monitor contract closely -- all aspects.
- Participate in all field operations, check laboratory procedures, count heads, etc.
- TDY to field locations during operations is necessary.

SLIDE 19 IN MANAGING (cont)

- Hold frequent contractor meetings -- require this in contract.
- Detailed planning sessions for coordination should be held prior to field operations, especially if to be coordinated with Corps activity.
- Require monthly progress and data reports and review these thoroughly, especially interim findings -- expect no surprises in the final report. Use consultants if necessary.
- Require midproject (interim) report and ask for preliminary conclusions, if any, determine if scope is being met.
- Review draft final report -- conduct peer or consultant review if necessary.
- Contract/project management must be active rather than passive.


SYSTEM ELEMENTS
NOVEMBER 5 12 19 26
DECEMBER 3 10 17 24 31
JANUARY 7 14 21 28
FEBRUARY 4 11 18 25
MARCH 4 11 18 25
AVAILABILITY OF SEDIMENT ADSORBED PESTICIDES
S/W IHR P/RFP ADV Eval Negot Eval AWD
VERTICAL MIGRATION ABILITY OF BENTHOS IN DREDGED MATERIAL DEPOSITS
S/W IHR P/RFP ADV Eval Negot Eval AWD
AVAILABILITY OF SEDIMENT ADSORBED HEAVY METALS
S/W Eval S-S Negot Eval AWD
EFFECTS OF THE PHYSICAL CHARACTERISTICS OF SUSPENDED PARTICLES ON BENTHOS: COMPARISON OF GEOGRAPHICAL RACES
Memo S/W IHR P/RFP ADV Eval Negot Eval AWD

APPENDIX B

REQUEST FOR PROPOSAL

Section A

AQUATIC DISPOSAL STUDY AT ASHTABULA
HARBOR, LAKE ERIE, OHIO

Introduction. This solicitation is requesting proposals on three separate studies, which will be conducted at Ashtabula Harbor, Lake Erie, Ohio. As a prospective contractor, you may find that more than one of the studies would be of interest. It is requested that a separate proposal be submitted for each of the studies for which you would like to be considered. If you submit more than one proposal, please include a section in which duplicate costs are identified in the event you are awarded more than one of the studies.

Background Information for Work to be Done. Environmental Effects Laboratory (EEL) of the Waterways Experiment Station (WES) is planning and conducting a research program for the Office, Chief of Engineers on the disposal of dredged material. The Dredged Material Research Program (DMRP) has as its objective to provide more definitive information on the environmental aspects of dredging and disposal operations and to develop technically satisfactory, environmentally compatible, and economically feasible dredging and disposal alternatives, including consideration of dredged material as a manageable resource.

This work unit is an integral part of an extensive interdisciplinary research effort to identify and determine the short-and long-term impacts associated with the disposal of dredged materials and in particular the significance of physical, chemical, and biological factors that govern the rate, extent, and diversity by which open-water disposal sites are colonized by benthic communities.

It is generally agreed that due to seasonal factors and the subtle nature of changes in benthic communities, on-site, long-term investigations are needed to adequately document and assess cause-and-effect relationships between disposal activities and biological responses. In order to evaluate these changes and cause-and-effect relationships, a comprehensive research program will have to be conducted on the sites and on the surrounding areas with the purpose of defining responses due to natural and unnatural perturbations in the surrounding sediment regime, water column, and the associated flora and fauna of each.

To provide additional background information to prospective contractors, a general research plan of the Aquatic Disposal Research Project has been included (Incl. 1) It is emphasized that proposals submitted by prospective contractors consider only the scopes of work associated with this solicitation.

STUDY NO. 1

I: Study No. 1

A. Statement of work for AN INVESTIGATION OF PLANKTONIC COMMUNITIES, BENTHIC ASSESMBLAGES, AND THE FISHERY ASSOCIATED WITH THE ASHTABULA HARBOR STUDY AREA.

B. Scope of Work - General. The work to be done hereunder consists of furnishing and delivering to the Government all services, labor, materials, supplies and equipment necessary to conduct A STUDY OF PLANKTONIC COMMUNITIES, BENTHIC ASSEMBLAGES, AND THE FISHERY ASSOCIATED WITH THE ASHTABULA HARBOR STUDY AREA.

1. The contractor will be required to participate in quarterly briefings and interim meetings with the EEL site manager and all the contractors undertaking research efforts in the study area, as well as annual meetings with all of the above plus other representatives of the EEL for the purpose of evaluating the total research program. The contractor will be required to supply data as it becomes available to any regional contractor requesting such information. Data will be recorded on predetermined forms for efficient transferral to the EEL data storage and retrieval center.

2. The conceptual framework of the overall research effort to be undertaken at the study area will be subject to modification, therefore, the contractor should be prepared to respond dynamically to such expected changes and modifications. Additional parameters may have to be included or deleted in the investigation when sufficient evidence warrants it. It is emphasized that an experimental design shall be formulated for all biological sampling programs to optimize statistical and other comparisons and evaluation of the data.

C. Task I. INVESTIGATION OF THE PLANKTONIC COMMUNITIES ASSOCIATED WITH THE ASHTABULA HARBOR STUDY AREA.

1. Scope. The contractor, in accordance with the task descriptions below, shall survey and evaluate existing information, as well as develop and accomplish a research program that will accurately and effectively describe spatial, temporal as well as vertical distribution patterns of phytoplankton and zooplankton populations within the designated disposal site and a sufficient area surrounding the site, for a period of 12 months.

a. A literature survey shall be conducted, continuous with the project, which shall include a compilation and analysis of existing data on plankton community associations, spatial and temporal distribution patterns and productivity both within the study site area, and within the regional area ot concern. The primary objective of this aspect of the study will be to evaluate to what extent possible cause-effect relationships derived from the studies can be applied, in terms of a predictive capability within similar environments. Copies of all references cited in reports will be submitted to the EEL upon completion of the study.

b. The data resulting from this baseline survey as well as data resulting from associated physico-chemical and biological work units in the disposal site area shall be used to establish areas for the controlled disposal of dredged material and to establish permanent sampling stations within each site as well as reference or control areas.

c. The major emphasis of the study will be placed on productivity, food-chain relationships, spatial and temporal distribution patterns, species composition and relative abundance. Specifications for the sampling, analysis, and units in which to report the data follow.

2. Specifications. A sampling and analysis program will be established to evaluate the acute effects associated with the disposal of dredged materials on the planktonic community structure of the study area. This will require establishing baseline conditions immediately prior to disposal activities and will take into consideration changes which occur during and after such activities. Additionally, a more intensive sampling program will be formulated to evaluate the degree to which the study area provides suitable habitat for meroplanktonic forms (larval fishes and eggs).

The study will consider:

a. Phytoplankton. A sampling program should be established to adequately describe the vertical as well as horizontal distribution of the phytoplankton community within the study area prior to, during, and after the disposal of dredged materials. Sampling will be accomplished with a suitable, large volume water bottle. Enumeration should be of unpreserved samples and should be accomplished 2-3 hours after collection. If preservation is necessary, 3.6 percent merthiolate preservative should be used. Actual counts are to be made with an inverted microscope or counting chamber. Numbers will be reported as numbers per liter. Primary production should be estimated using the in vivo carbon-14 method, production profile curves should be generated and results should be reported as gC/1/24 hours and $gC/m^2/24$ hours. Identification should be to the species level for all common forms and for lesser forms where practical.

In those cases where identification to the species level is impossible, organisms will be at least differentiated for the computation of diversity indices.

Concentration of chlorophyll and related plant pigments in the water column will be determined by filtering the water sample through a Millipore AA filter, dissolving the filter in 90 percent acetone, centrifugation, and measurement of the supernatant on a spectrophotometer. Prior to millipore filtration, the sample will be filtered through a nylon netting 150u mesh to remove zooplankton and fibrous contaminants. Measurement will be made at the following wavelengths: 6650, 6450, 6300, 5100, and 4800 Å.

The equations of Parsons and Strickland (1963) will be used to calculate the concentrations of chlorophyll a, b, c, and plant carotenoids. Correction for interference by chlorophyll degradation products will be employed by treatment with dilute HCl after the above readings are made. The methods are described in Strickland and Parsons (1972).

Sensitivity for the above calculations is adequate down to pigment concentration of 0.2 mg/m^3. Below this, fluorometric techniques should be employed (Strickland and Parsons, 1972). Data will be reported as mg/m^2 and mg/m^3.

b. Zooplankton. A sampling program should be established to adequately describe the vertical as well as horizontal distribution of the zooplankton community within the study area prior to, during, and after the disposal of dredged material. The study shall be designed to evaluate both holoplanktonic and meroplanktonic forms that may be important links in the pelagic food chains, that indicate the potential for recolonization of the benthic communities, and that indicate spawning and nursey grounds for fin fish, particularly the commercially important forms and those forms that are predators of the benthos.

In addition to the above short-term study, a more intensive sampling program will be formulated with the objective of evaluating the study area relative to meroplanktonic forms (larval fishes and eggs). It is anticipated that the period of study will at least include the spawning cycles of the important commercial and sport fishes. Due to the fact that the organisms making up a zooplankton community vary widely in size and ability to evade plankton nets, the sampling efficiency of a net of one mesh size may not be adequate to quantitatively sample all components of the community. Therefore, metered nets of different mesh sizes will be towed in concert.

At all sampling stations, discrete horizontal tows are to be made as well as vertical tows (bottom to surface). Samples will be preserved with buffered formalin for storage before analysis.

Identification should be to the species level for all common forms and for the lesser forms where practical. In those cases where identification to the species level is impossible, organisms will be at least differentiated for the computation of diversity indices. Data should be reported as numbers per liter.

Literature Cited

(a) Strickland, J. D. H. and T. R. Parsons, 1972. A practical handbook of seawater analyses. Fish Res Bd Canada Bull 167. 310 pp.

(b) Parsons, R. T. and J. D. H. Strickland, 1963. Deep Sea Res 21:155.

D. Task II. INVESTIGATION OF BENTHIC ASSEMBLAGES ASSOCIATED WITH THE ASHTABULA HARBOR STUDY AREA.

1. Scope. The contractor, in accordance with the task description below, shall survey and evaluate existing information, as well as develop and undertake a research program that will accurately and effectively describe spatial, temporal as well as vertical distribution patterns of benthic populations within the designated disposal site and a sufficient area surrounding the site for a period of 12 months.

a. A literature survey shall be conducted, concurrently with the project which shall include a compilation and analysis of existing data on benthic community associations and spatial and temporal distribution patterns, both within the study site area, and within the regional area of concern. The primary objective of this aspect of the study will be to evaluate to what extent possible cause-effect relationships derived from the long-term studies can be applied, terms of a predictive capability, with similar environments. Copies of all r erences cited in reports will be submitted to the Government upon completion of the study.

b. The baseline field investigations will include analyses and comparisons of specified sampling devices as to relative sampling efficiency and effectiveness. Specified grab and box corer sampling devices will also be compared as to depth of penetration, volume of material retrieved, species selectivity, and ease of operation as a function of sediment type.

c. The data resulting from this baseline survey as well as data resulting from associated physico-chemical and biological work units in the disposal site area will be used to establish areas for the controlled disposal of dredged material and to establish permanent sampling stations within each site as well as reference or control areas.

d. The major emphasis of the study will be placed on benthic species communities; as to structure, spatial and temporal distribution patterns and composition. Specifications for the sampling, analysis, and units in which to report each of these parameters follow.

2. Specifications. For purposes of standardization between study site areas, the macrobenthos will be differentiated from the meiobenthos as that being retained on a #30 mesh screen. To insure the technical validity of the data, and since no one sampling method is able to provide quantitative samples of all components of the benthos, a combination of sampling methods will be utilized. In order to make the data comparable between regions of similar environmental types, sampling methods will be standardized wherever practical.

During the baseline data collection phase, the location and number of benthic stations will be related to the physical and chemical studies within the study site area. Frequency of sampling is tentatively envisioned to be at two month intervals during the baseline data collection phase.

a. Macrofauna. The Ponar grab will be the standard grab sampler for quantitative studies of macrofauna within the entire study area. The grab sampler data will be utilized primarily in defining spatial and temporal distribution patterns over the entire study area. The box corer will be utilized on a more limited basis for the study of vertical distribution patterns and vertical migration within the sediment column of the controlled disposal sites and related reference areas. Replicate samples shall be obtained using the devices specified above.

For epifaunal studies and the evaluation of the species selectivity of sampling devices, supplemental sampling shall be accomplished employing a epibenthic sled with odometer wheels to measure distance.

Meiofauna. Subsamples shall be obtained from the box core samples for the determination of vertical distribution patterns of meiofaunal populations within the sediment column. Replicate samples shall be obtained with an appropriate coring device. For spatial and temporal meiofaunal distribution pattern investigations, replicate samples shall be obtained by utilizing coring devices of above specified dimensions.

b. Data Analyses. The macrobenthic forms shall be preserved and narcocized upon collection; the meiobenthos should be refrigerated before enumeration.

The macrofauna shall be identified and enumerated to the species level if practical at all times. Additionally, selected dominate species of macrofauna should be enumerated according to age and/or size classes. Sample data should be reported both as numbers per area sampled and as numbers per volume sampled (no./m^2 and no./l of sediment).

The meiobenthic forms shall be identified and enumerated to the species level where possible, especially the larval macrofauna. Sample data shall be reported both as numbers per area sampled and as numbers per volume of material sampled (no./m^2 and no./l of sediment). In those cases where identification to the species level is impossible, organisms will be at least differentiated for the computation of diversity indices.

Biomass determinations shall be made as ash free dry weight for dominate forms of both components of the benthos. Additionally, preserved reference collections for both components of the benthos shall be maintained and provided to the EEL upon request. Procedures as outlined in "Biological Field and Laboratory Methods, EPA-G70/4.73-001," should be followed with the exception of oven drying the organisms to a constant weight at 100 degrees centigrade.

E. Task III. INVESTIGATION OF THE FISHERY* ASSOCIATED WITH THE ASHTABULA HARBOR STUDY AREA.

1. Scope. The contractor, in accordance with the descriptions below, shall survey and evaluate existing information, as well as develop and undertake a sampling program that will accurately and effectively describe spatial and temporal as well as vertical distribution patterns of fishery associated populations within the designated disposal site and a sufficient area surrounding the site, for a period of 12 months. Frequency of sampling is envisioned to be on a seasonal basis, using appropriate sampling methods for the environment and for the types of populations to be sampled. A quantitative-oriented approach to sampling will be stressed.

A literature survey shall be conducted, concurrently with the project, which shall include a compilation and analysis of existing data on spatial and temporal distribution patterns and relative abundance of fishery associated populations both within the study site area and within the regional area of concern. Particular emphasis shall be placed on species-habitat associations as a function of sediment type and depth. The primary objective of this aspect of the study will be to evaluate to what extent possible cause-effect relationships derived from the long-term studies can be applied, in terms of a predictive capability with similar environments. Xerox copies of all references cited in reports will be submitted to the Government upon completion of the study.

The data resulting from the baseline survey as well as data resulting from associated physico-chemical and biological work units in the disposal site area shall be used to establish areas for the controlled disposal of dredged material and to establish permanent sampling stations within each site as well as reference or control areas.

The major emphasis of the study should consider spatial and temporal distribution patterns, relative abundance, species composition, gear selectivity, and food chain relationships, particularly with the benthos.

2. There are no further specifications for this Task.

---

*For study purposes, fishery will be defined as those species of major sport or commercial value within the region of concern, and, additionally, the nekton associated directly with the benthos.

S T U D Y N O. 2

II. Study No. 2

A. Statement of Work for an INVESTIGATION OF THE HYDRAULIC REGIME AND THE PHYSICAL NATURE OF BOTTOM SEDIMENTATION ASSOCIATED WITH THE ASHTABULA HARBOR STUDY AREA.

B. Scope of Work. The work to be done hereunder consists of furnishing and delivering to the Government services, labor, materials, supplies, and equipment necessary to conduct AN INVESTIGATION OF THE HYDRAULIC REGIME AND THE PHYSICAL NATURE OF BOTTOM SEDIMENTATION IN THE ASHTABULA HARBOR DISPOSAL SITE as described in the following subparagraphs.

1. The contractor, in accordance with the descriptions listed below, shall survey and evaluate existing information, as well as develop and undertake a research program that will accurately and effectively document the current velocity and direction through the water column, the wave activity, meteorological and lake level fluctuations, and characterize the disposal site and surrounding area according to expected levels of sediment movement under varying environments.

2. The frequency of data gathering and observation will be dependent on the research schedules of other associated work units in the study area as well as natural phenomena such as storms, high river runoff, periods of extraordinary weather, or water column stability. The intent of the program is to develop comprehensive data with an initial concentrated sampling effort for approximately 12 months.

3. The contractor will be required to participate in quarterly briefings and interim meetings with the site manager and all the contractors undertaking research efforts in the study area. The contractor will be required to supply data as it becomes available to any regional contractor requesting such information. Data will be recorded on predetermined forms for efficient transferral to the EEL data storage and retrieval center.

4. Description of field investigations. The contractor shall evaluate available bathymetric charts and existing knowledge and data, and determine the number of permanent stations that will be established which will be used throughout the investigation for *in situ* sampling. The data obtained from these stations will basically describe and delineate the hydraulic regime and the bottom sedimentation characteristics of the dump site and surrounding area. Other stations will be occupied in response to the specific dumping activities and other research efforts in the study area. Instrumentation and equipment that will be used during the investigation will include current meters for vertical profiles and suspended sediment samplers (small rosette of water bottles, sediment traps), underwater camera, drift bottles, drogues, bottom drifters and dyes (tracers).

5. The contractor shall undertake investigations, observations, and sampling during the range of environmental conditions -- calm versus storms, high and low lake levels, wave dominance, etc. -- and evaluate the sedimentary response to specific energy sources. The data will be documented and recorded on predetermined forms for efficient transferral to the Government data storage and retrieval center. The contractor will be responsible for maintaining a required schedule of calibration and testing of all instruments and equipment used in the investigation. The conceptual framework of the overall research effort to be undertaken at the study area will be subject to modification and the contractor should establish a proposed plan of research that can respond dynamically to such expected changes and modifications. It is emphasized that an experimental design shall be formulated for all sampling programs to optimize statistical and other comparisons and evaluation of the data.

6. There are no further specifications for this study.

S T U D Y N O. 3

III. Study No. 3

A. Statement of Work for an INVESTIGATION OF THE WATER QUALITY PARAMETERS AND THE PHYSICO-CHEMICAL SEDIMENT PARAMETERS IN THE ASHTABULA HARBOR DREDGED MATERIAL DISPOSAL SITE.

B. Scope of Work. The work to be done hereunder consists of furnishing and delivering to the Government, all services, labor, materials, supplies, and equipment necessary to conduct a study of A LONG-TERM INVESTIGATION OF THE WATER QUALITY PARAMETERS AND THE PHYSICO-CHEMICAL SEDIMENT PARAMETERS IN THE ASHTABULA HARBOR DREDGED MATERIAL DISPOSAL SITE as described in the following subparagraphs.

1. The contractor, in accordance with the task descriptions listed below, shall survey and evaluate existing information, as well as develop and undertake a research program that will accurately and effectively describe the baseline water quality parameters and physio-chemical sediment parameters of the Ashtabula Harbor disposal site and a sufficient area exclusive and surrounding the site that will enable the establishment of permanent sampling stations within the site as well as permanent sampling stations outside the site in a reference or "control area."

2. The data resulting from the baseline survey as well as data resulting from associated work units in the disposal site area shall be used to establish areas for controlled dumping of dredged material.

3. An investigation of the water quality and sediment parameters shall continue for approximately 12 months after initiation of the program in order to document changes in these parameters due to the disposal of dredged material. The baseline sampling will be undertaken in such a manner as to assure conclusive documentation of the distribution of constituents specifically within the designated disposal site and adjacent area. The frequency of data collections will be dependent on the research schedules of other associated work units in the study area as well as frequency of natural phenomena such as storms, high river runoff, periods of extraordinary weather, or water column stability.

4. The contractor will be required to participate in quarterly briefings and interim meetings with the EEL site manager and all the contractors undertaking research efforts in the study area, as well as annual meetings with all the above plus other representatives of the EEL with the purpose of evaluating the total research program. The contractor will be required to supply data as it becomes available to any contractor requesting such information. Data will be recorded on predetermined forms for efficient transferral to the EEL data storage and retrieval center.

5. The water quality investigation will entail a vertical characterization of the water column with particular emphasis being placed on the interfacial water (that which is just above the sediments). Specific parameters to be measured are: temperature, dissolved oxygen, pH, Eh, alkalinity, sulfate, conductivity, nutrients,

light transmission, the characterization of suspended particles, and heavy metals. Specifications for the sampling, analysis, and units in which to report each of these parameters are attached.

6. The investigation of the sediment parameters will entail a vertical characterization of the sediments. Specific parameters to be measured are: Eh, pH, total sulfide, percent water, particle size distribution, mineralogy, nutrients, trace metals, oils and grease, and cation exchange capacity. Specifications for the sampling, analysis, and units in which to report each of these parameters are included and entitled "SPECIFICATIONS FOR THE SAMPLING AND ANALYSIS OF THE SEDIMENTS."

7. The conceptual framework of the overall research effort to be undertaken at the study area will be subject to modification, therefore the contractor should be prepared to respond dynamically to such expected changes and modifications. Additional parameters may have to be included or deleted in the investigation when sufficient evidence warrants it. It is emphasized that an experimental design shall be formulated for all sampling programs to optimize statistical and other comparisons and evaluation of the data.

C. SPECIFICATIONS FOR THE SAMPLING AND ANALYSIS OF WATER QUALITY PARAMETERS.

1. Sampling. The choice of samplers for the following water column parameters will be any water column sampling bottle that is made of, or lined with, an inert PVC material and has no rubber closers. Any metal parts that could possibly give rise to contamination will be coated a minimum of seven times with a non-contaminating plastic spray. These bottles will allow for the least possible contamination of the water sample.

2. Methods for Analysis of Water Quality Parameters. The parameters listed below will be used to determine baseline water quality information. This consists of a vertical profile with concentrated efforts on the water column just above the bottom.

a. Temperature

b. Dissolved oxygen

c. Conductivity

d. pH

e. Alkalinity

f. Sulfate

g. Nutrient levels

(1) Nitrate - N

(2) Nitrite - N

(3) Ammonia - N

(4) TKN

(5) Ortho-PO_4-P

(6) Total - P

(7) Silicate

(8) Dissolved Organic - C

h. Eh

i. Heavy metals

j. Suspended particles

(1) Particle size distribution and concentration

(2) Organic fraction

(3) Associated heavy metals

k. Light transmission

Unless otherwise specified, all methods given are found in "Methods for Chemical Analysis of Water and Wastes," 1971, Environmental Protection Agency Water Quality Office, and will be referred to as EPA's Manual. These methods were chosen using Standard Methods for the Examination of Water and Wastewater, 13th Edition (1971), ASTM Standards, Part 23, Water Atmosphere Analysis (1970); and Current Water Pollution Control Literature as basic references. The following paragraphs present each method along with pertinent references. If an automated technique is in wide use for a particular analysis, reference will be made to it.

Sampling and preservation of samples are discussed in EPA's manual. These instructions should be followed closely and all precautions they suggest should be used.

3. Temperature, Dissolved Oxygen, Conductivity, and pH. The above parameters will all be measured by *in situ* probes. The types of probes and the methods of placement will be determined by the site manager and contractor. Temperature will be reported as ^{o}C, dissolved oxygen as mg/l, salinity as 0/00, and conductivity as umhos/cm^3.

4. Alkalinity. Alkalinity is to be determined by the methyl orange method as given on pages 8-10 of EPA's manual. This method is applicable in the range 10-200 mg/l. For alkalinities less than 10 mg/l the potentiometric determination given on pages 6-7 of EPA's manual will be used. Data is to be reported as mg/l $CaCO_3$.

5. Sulfate. Sulfate is to be determined by the chloranilate method as given on pages 288-291 of EPA's manual. This method is applicable in the range 10-400 mg/l. Data is to be reported as mg SO_4/l.

6. Nutrients.

(a) Nitrate - N

This method pertains to the determination of nitrates and nitrites, singularly or combined, present in fresh saline waters. The prescribed specifications permit analyses of samples in the range of 0.05 to 10 mg/l, N present as NO_3.

The initial step is to reduce the nitrates to nitrites with cadmium-copper catalyst. The nitrites (those originally present plus reduced nitrates) are reacted with sulfanilamide to form a diazo compound which is then coupled with N-1 naphthyletylenediamine hydrochloride at pH 2.0 - 2.5 to form the azo dye. The azo dye intensity, which is proportional to the nitrate concentration, is then measured. Separate rather than combined nitrate-nitrite values are readily obtainable by carrying out the procedure-- first with, and then without, the initial Cd-Cu reduction step. Methods are found on pages 175-182 of EPA's manual. Data is to be reported as mg/l Nitrate-N.

(1) O'Brien, J. E. and J. Fiore, 1962. Automation in sanitary chemistry - parts 1 and 2, determination of nitrates and nitrites, Wastes Engineering 33: 128-238.

(2) Strickland, J. D., C. R. Stearns, and F. A. Armstrong, 1967. The measurement of upwelling and subsequent biological processes by means of the Technicon Auto Analyzer and associated equipment. Deep Sea Res 14: 381-389.

(3) ASTM Manual on Industrial Water and Industrial Waste Water, 1961. Method D 1254, page 465.

(4) Chemical Analyses for Water Quality Manual, January 1966. Department of the Interior. FWPCA, R. A. Taft Sanitary Engineer Center Training Program, Cincinnati, Ohio. 45226

(5) "ASTM Manual on Industrial Water and Industrial Waste Water." Substitute Ocean Water, Table 1, page 418, 1966 edition.

(b) Nitrite - N

This method is for the determination of nitrite in surface waters, domestic and industrial wastes and saline waters in the range from 0.05 to 1.0 mg/l NO_2/N.

(c) Ammonia - N

This distillation method can be used to measure ammonia - N exclusive of total Kjeldahl nitrogen, in surface waters, domestic and industrial wastes, and saline waters. It is the method to use when economics and sample load do not neccessitate the use of automated equipment. The method covers the range from about 0.05 to 1.0 mg/l NH_3/N per liter for the colorimetric procedures and from 1.0 to 25 mg/l for the titrimetric procedure.

The sample is buffered at a pH of 9.5 with a borate buffer in order to decrease hydrolysis of cyanates and organic nitrogen compounds. It is then distilled into a solution of boric acid. The ammonia in the distillate can be determined either colorimetrically by nesslerization or titrimetrically with standard sulfuric acid with the use of a mixed indicator. The choice between these two procedures depends on the concentration of the ammonia. The methods are described in EPA's manual on pages 134-141.

The results will be reported as mg/l ammonia - N. The automated method can also be used.

Depending upon the selection of the size of the flow cell, and extent of dilution, concentrations in the range between .01 and 20 mg/l N present as NH_3 may be determined.

The intensity of the indophenol blue color (1), formed by the reaction of ammonia with alkaline phenol hypochlorite, is measured. Sodium nitroprusside is used to intensify the blue color. This method is described in EPA's manual on pages 141-149 and it will be reported as with the manual technique.

(1) Van Xlyke, D. and A. Miller 1933. Determination of ammonia in blood, J. Biol. Chem. 102:499.

(2) O'Conner, B., R. Dobbs, B. Villiers, and R. Dean, 1967. Laboratory distillation of municipal waste effluents. JWPCF 39:R 25.

(3) O'Brien, J. E. and J. Fiore. 1962. Ammonia determination by automatic analysis. Wastes Engineering 33:352.

(4) A wetting agent recommended and supplied by the Technicon Corporation for use in Auto Analyzers.

(5) ASTM. 1966. Manual on Industrial Water and Industrial Waste Water. 2nd Ed. 418 pp.

(d) Total Kjeldahl Nitrogen

This method can be used to determine total Kjeldahl nitrogen in surface waters, domestic and industrial wastes, and saline waters. The procedure converts biogenic nitrogen compounds such as amino acids, proteins, and peptides to ammonia, but may not convert the nitrogen compounds of some industrial wastes such as amines, nitro compounds, hydrazones, oximes, semi-carbazones and some refractory tertiary amines.

Two alternatives are listed for the determination of ammonia after distillation; the titrimetric method which is applicable to concentrations above 1 mg N/liter and the Nesslerization method which is applicable to concentrations below 1 mg N/liter.

The sample is heated in the presence of concentrated sulfuric acid, K_2SO_4, and Mg SO_4 and evaporated until SO_3 fumes are obtained and the solution becomes colorless or pale yellow. The residue is cooled, diluted, and made alkaline with a hydroxide-thiosulfate solution. The ammonia is determined by nesslerization or titrimetrically after distillation.

The above method is described on pages 149-156 of EPA's manual. Automated methods are located on pages 157-163. References for the automated method are given below. *Data will be reported as mg/l TKN.*

(1) Kammerer, P. A., M. G. Rodel, R. A. Hughes, and G. F. Lee, 1967. Low level Kjeldahl nitrogen determination on the Technicon Auto Analyzer. Environmental Science and Technology. 1(4):340.

(2) McDaniel, H., R. N. Hemphill, W. T. Donaldson. Automatic determination of total Kjeldahl nitrogen in estuarine waters. Presented at Technicon Symposium on Automation in Analytical Chemistry, New York, 3 October 1967.

(3) O'Conner, B. Dobbs, Villiers, and Dean, 1967. Laboratory distillation of municipal waste effluents. JWPCP. 39: R 25.

(e) Total Phosphorous and Ortho-Phosphate Phosphorous

These methods are used to determine the specified forms of phosphorous in surface waters, domestic and industrial wastes, and saline waters. The methods are based on reactions that are specific for the orthophosphate ion. Except for in-depth and detailed studies, the most commonly measured forms are total phosphorous and dissolved phosphorous, and orthophosphate and dissolved orthophosphate.

The methods are applicable to the 0.01 to 0.5 mg/l P range.

Ammonium molybdate and potassium antimonyl tartrate react under conditions with dilute solutions of phosphorous to form an antimony-phosphomolybdate complex. This complex is reduced to an intensely blue-colored complex by ascorbic acid. The color which is proportional to the ortho-phosphate concentration, is then measured. Polyphosphates (and some organic phosphorous compounds) may be converted to the orthophosphate form by sulfuric-acid-hydrolysis. Organic compounds may be converted to the orthophosphate form by decomposition, weathering and mineralization.

These procedures are described on pages 235-245 of EPA's manual. The automated procedures are found on pages 246-259. The data will be reported as mg/l.

(1) Mirphy, J. and J. Riley. 1962. A modified single solution method for the determination of phosphate in natural waters. Anal. Chim. Acta. 27:31.

(2) Gales, M., Jr., E. Julian, and R. Kroner, 1966. Method for quantitative determination of total phosphorous in water. Jour AWWA, 58 (10): 1363.

(f) Silicate

This method is applicable to drinking waters and surface waters, domestic and industrial wastes, and saline waters. Working range of method is 2 to 25 mg silica/l. The upper range can be extended by taking suitable aliquots; the lower range can be extended by the addition of aminonaphtholsulfonic acid solution.

A well-mixed sample is filtered through a 0.45 u membrane filter and molybdate ion in acidic solution added. The resulting complex is proportional to the dissolved silica. The method is given on page 273 of EPA's manual, and results will be stated as mg/l silicate.

(g) Dissolved Organic Carbon

This method includes the measurement of organic carbon in surface waters, domestic and industrial wastes, and saline waters in the range of 1 to 150 mg/liter.

A micro sample of the water to be analyzed is injected into a catalytic combustion tube inside an electric furnace thermostated at 950°C. The water is vaporized and the carbonaceous material is oxidized to carbon dioxide (CO_2) and steam in a carrier stream of pure oxygen or air. The oxygen flow carries the steam and CO_2 out of the furnace where the steam is condensed and the condensate removed. The CO_2, oxygen, and remaining water vapor go into an infrared analyzer sensitized to provide a measure of CO_2. The amount of CO_2 present is directly proportional to the concentration of carbonaceous material in the injected sample. The procedures are discussed

in EPA's manual on pages 221-229, and the results will be reported as mg/l Dissolved Organic Carbon.

7. Eh. The measurement will be made with a platinum electrode with a saturated colomel half-cell as reference.

8. Metals (Atomic Absorption Methods). Metals in solution will be determined by atomic absorption spectroscopy. Detection limits, sensitivity and optimum ranges of the metals will vary with the various makes and models of different atomic absorption spectrophotometers. Usually the concentration may be extended much lower with scale expansion and conversely extended upwards by using a less sensitive wavelength. Detection limits may also be extended through concentration of the sample or through solvent extraction techniques.

A pre-filtered sample is atomized and aspirated into a flame. A light beam is directed through the flame into a monochromator, and onto a detector that measures the amount of light absorbed. Since the wavelength of the light beam being absorbed is characteristic of only the metal being determined, the light energy absorbed by the flame is a measure of the concentration of that metal in the sample. Procedures for individual metals can be found in EPA's Manual on pages 98-130. Metals to be analyzed under this work unit are: As, Cd, Cu, Fe, Hg, Mn, N, Pb, and Zn. The results will be reported as mg/l.

(a) Atomic Absorption Newsletter. 7:35(1968)

(b) Spectrochim Acta. 24B:53(1969)

(c) Atomic Absorption Newsletter. 6:128(1967)

9. Suspended Particles.

(a) Particle Size Distribution and Concentration

The concentration of suspended material will be determined by filtration through a tared Millipore AA filter, washing to free the sample of salts, and drying at 75°C until the weight is constant. The procedure and precautions should follow those given by Strickland and Parsons (1972). Data will be expressed as mg/l.

The particle size distribution will be determined by the sieve-pipette method (H. P. Guy, 1969) and reported as percent of the following size ranges: 2-1 mm, 1-0.5 mm, 0.05-0.25 mm, 0.25-0.125 mm, 0.125-0.062 mm, 0.062-0.031 mm, 0.031-0.016 mm, 0.016-0.008 mm, 0.008-0.004 mm, 0.004-0.002 mm.

(1) Strickland, J. D. H. and T. R. Parsons, 1972. A practical handbook of seawater analysis. Fish Res Bd Canada. Bull 167. 310 pp.

AD-A101 803 CORPS OF ENGINEERS WASHINGTON DC F/G 13/2
PROCEEDINGS OF A SEMINAR ON WATER QUALITY DATA COLLECTION AND M--ETC(U)
1977

UNCLASSIFIED NL

2 OF 2
AD A
101803

END
DATE
FILMED
8-81
DTIC

(2) Guy, H. P., 1969. Laboratory theory and methods for sediment analysis. Book 5. U.S.G.S. 59 pp.

(b) Organic Fraction

Particulate organic - C will be determined by wet oxidation with dichromate as described by Strickland and Parsons (1972, p. 207-211). Data will be expressed as mg/l.

(1) Strickland, J. D. H. and T. R. Parsons, 1972. A practical handbook of seawater analysis. Fish Res Bd Canada. Bull 167. 310 pp.

(c) Associated Heavy Metals

Metals will be determined by atomic absorption spectroscopy after filtration (glass fiber filter) and acid digestion of the suspended material. Procedures for individual metals are found in EPA's manual on pages 98-130. Metals to be analyzed are As, Cd, Cu, Fe, Hg, Mn, Ni, Pb, and Zn. The results will be reported as ug/l.

(1) Atomic Absorption Newsletter &;35 (1968).

(2) Spectrochim Acta 24B:53 (1969).

(3) Atomic Absorption Newsletter. 6:128 (1967).

10. Light Transmission. A Hydroproducts, OEC Model 412 or a comparable transmissometer will be used. Data will be reported as percent transmission.

D. SPECIFICATIONS FOR THE SAMPLING AND ANALYSIS OF SEDIMENTS.

1. Sampling. Sediment samples will be taken with a suitable coring device that is equipped with a plastic liner. Care should be taken in the choice of the liner since certain plastics have relatively high levels or trace metals. The length of the corer should be 6 ft. with the inside diameter of the liner at least 6 cm. A plastic core-catcher will be employed in the barrel of the corer. Any metal parts that could possibly give rise to contamination, such as the cutting nose of the corer, will be coated a minimum of seven times with a non-contaminating plastic spray. The length of the core sample will depend upon the type of sediment itself; however, analysis should be made of the top 10-cm section and the lower sections of 25-cm lengths. In situations where changes in lithology occur within individual sections, it will be necessary to vary the lengths or positions of these subsamples in the core.

Immediately after taking the core, the plastic liner is sealed to prevent oxidation. The plastic caps commonly used to seal these liners have been noted to have contaminating levels of heavy metals. Steps should be taken to prevent this, such as placing teflon sheets between caps and sample, or coating the cap with a non-contaminating plastic spray. The cores should always be stored upright, preferably at the *in-situ* temperature. Storage at 4°C will be acceptable, however, the cores should *never be frozen*.

2. *Selective Extraction*. Extrusion of the core and the separation and extraction procedures outlined below are a modification of those given by Engler, et al. (in press). These procedures are intended to prevent any atmospheric oxidation which may cause phase or fraction differentiation of elements or chemical constituents within the sediments. Selective extraction is done on relatively undisturbed sediments, eliminating oxidation, drying, grinding, or other modifications of the physical or chemical state.

These extraction procedures are abbreviated to yield two phases:

a. Interstitial water

b. Total core, which consists of the exchangeable phase, reducible phase (solubility and migration dependent or redox reactions), bound organic phase, and residual phase (inter-layer positions on clay minerals or in a mineral crystalline lattice).

Extrusion of the core and the separation procedures will be done in a disposable glove bag under oxygen-free conditions (under nitrogen gas atmosphere). Verification of these conditions will be made with constant monitoring by a polargraphic oxygen analyzer.

(1) *Interstitial Water*. The sediment is extruded from the core liner into a plastic container and sectioned at 10 and 25 cm intervals (as indicated in 1 above). Each section is then split into halves with each section receiving individual treatment. One-half of each section is weighed into an oxygen-free, tared, polyethylene 500 ml centrifuge tube in the glove bag; centrifuged at 9000 rpm for 5 minutes at 5°C; the interstitial water vacuum filtered under nitrogen through a pre-rinsed 0.45u membrane filter, and immediately acidified to pH 1. This fraction can then be stored for subsequent analysis.

This fraction shall be analyzed for total organic carbon (dissolved), total Kjeldahl nitrogen (dissolved), nitrate, nitrite, ammonia, orthophosphate, Fe, Mn, Hg, As, Cd, Cu, Ni, Pb, and Zn.

Methods for each of these are outlined in the section "Specifications for the Sampling and Analysis of Water Quality Parameters" and will be reported in units of mg/l of interstitial water.

(2) Total Core Analysis. The remaining half of the original sediment core sample will be used for: Eh, pH characterization, total sulfide, percent water, particle size distribution, mineralogy, total organic carbon, total organic nitrogen, ammonium, total phosphorous, bulk analysis of the trace metals analyzed in the interstitial water, oils and grease, phenols, and the cation exchange capacity. Eh, pH, and total sulfide analysis will be made on the fresh cores as soon as possible after obtaining these cores in the field. Particle size distribution and mineralogy will be done on the wet sample. Measurement of the remaining parameters are unaffected by oxygen changes and therefore will be made on each section after drying at 70°C and grinding to pass a 200 mesh sieve. This material can then be stored until analysis is made.

(a) Eh and pH. Measurement of these two parameters will be made in the center of each core section (sectioning described in "1. Sampling" above). Eh measurement will be made with platinum electrode with a saturated colomel half-cell as reference; pH measurement will be made with microelectrode.

(b) Total sulfide. Total sulfide content of each section will be determined by titrimetric (iodine) method (American Public Health Association, 1971) and will be reported in units of mg/kg of wet sediment.

(c) Percent water. Percent water of each section will be determined gravimetrically by drying at 70°C until the weight is constant.

(d) Particle size distribution. Percent sand (>63 u), silt (2-63u) and clay (<2u) will be determined for each section by the sieve-pipette method (H. P. Guy, 1969). The sand fraction will be characterized as to the following size ranges: 2.0 - 1.0 mm, 1.0 - 0.50 mm, 0.50 - 0.25 mm, 0.25 - 0.125 mm, 0.125 - 0.062 mm.

(e) X-ray diffraction analysis. X-ray diffraction analysis will be used to characterize the mineralogy of the size fractions. (percent chlorite, calcite, illite, kaolinite, montmorilorite).

(f) Total organic carbon. Measurement of this parameter on each section will be made by dry combustion with the gravimetrical determination of evolved CO_2 (Allison, et al. 1965) after correcting for inorganic carbon (Allison, 1965).

(g) Total organic nitrogen. Each section will be analyzed for this parameter using the micro-Kjeldahl method described by Jackson (1958). Total organic nitrogen will be reported as mg/kg dry sediment.

(h) Ammonium and total phosphorous. These constituents will be determined for each section by methods described by Jackson (1958 and will be reported as mg/kg of dry sediment.

(i) <u>Cation exchange capacity</u>. This is the measure of the degree to which sediment can bind cations (including heavy metals) in a readily exchangeable form. Methods described by Jackson (1958) will be used.

(j) <u>Oil and grease</u> will be measured by trichlorotifluoroethane extraction; or, in heavily polluted sediments, utilizing the hydrocarbon-fatty matter separation by adsorption on activated alumnia (American Public Health Association, 1971). Oils and grease will be reported as mg/kg of dry sediment.

LITERATURE CITED

Allison, L. E., W. Boller, and C. D. Moodie, 1965. Total carbon, In C. A. Black (ed.) Methods of Soil Analysis, Part II. Agronomy 9; 1346-1366. Amer. Soc. Agron. Madison, Wis.

Allison, L. E., 1965. Organic Carbon. In C. A. Black (ed.), Methods of Soil Analysis, Part II. Agronomy 9: 1367-1378. Amer. Soc. Agron., Madison, Wis.

Guy, H. P., 1969. Laboratory Theory and Methods for Sediment Analysis. Book 5. U.S.G.S. 58 p.

Jackson, M. L., 1958. Soil Chemical Analysis. Prentice-Hall, Inc. Englewood Clifts, N.J. 498 p.

American Public Health Association, 1971, Standard Methods for Examination of Water and Wastewater. APHA, 13 ed., New York. 874 p.

SCHEDULE AND REPORTING PROCEDURE

I. Schedule and Reporting Procedure.

A. The contractor shall provide in his proposal a projected schedule consisting of the following activities. The schedule shall use weeks as a time scale starting with the effective date of the contract.

a. Design of Experiment.

b. Data Collection.

c. Data Analysis.

d. Analytic Development.

e. Draft Report Preparation.

f. Draft Report Submission.

g. Final Report Review Submission.

B. Reports.

1. Monthly Progress Reports. Three copies of brief letter-type progress reports shall be submitted monthly describing work performed during the month and work planned for the next month in accordance with the schedule described in paragraph A above.

2. Quarterly Summary Reports. Three copies of letter-type reports shall be submitted quarterly describing work performed during the quarter and work planned for the next quarter in accordance with the schedule described in A above.

3. Final Report. Upon completion of all work, the contractor shall furnish a draft copy of a final report covering all items of work and services performed. The contractor shall submit this draft copy to the contracting officer for review and approval of format, method of presentation, and compliance with applicable contract requirements. Upon return of the draft, the contractor shall prepare and furnish the contracting officer a reproduction copy of the technical report. Technical findings shall not be subject to approval of the contracting officer, but recommendations by the contracting officer for changes in the findings which are acceptable to the contractor will be incorporated in the final reproduction copy. Should such recommendations be unacceptable to the contractor, the reproduction copy will contain an appropriate statement that the technical findings do not necessarily reflect the view nor have the concurrence of the U. S. Army Corps of Engineers. The draft and final report will be prepared as described in the Instruction Report 0-74-2, which is inclosed. Printing, binding, and distribution will be accomplished by the Government. Appropriate recognition will be given the contractor in the final version.

SECTION B

DELIVERY OR PERFORMANCE

I. Time of Completion of Work.

A. The monthly letter report shall be submitted to the contracting officer not later than the 10th of the month following the reporting period.

B. The quarterly summary report shall be submitted to the contracting officer not later than the 10th day following the end of the quarter.

C. It is desired that all work will be completed within 365 calendar days after the effective date of the contract, and that the draft of the final report will be submitted 35 days prior to the completion date. Submission of an acceptable reproduction copy of the final report will conclude the work.

SECTION C

EVALUATION FACTORS FOR AWARD

I. Evaluation of Proposals. All proposals will be evaluated and weighed as follows, in descending order of importance:

A. Experience and expertise of contractor in related areas of research.

B. Overall concept or scenario functionally relating the proposed problem to assumptions and to the anticipated approach for obtaining the final solution.

C. Methodology of the various technical parts of the study.

D. Form of portrayal of results.

E. Costs.

F. Amount and detail of data proposed to be supplied.

G. Scheduled compeletion times for interim and final reports.

THE CASE HISTORY OF THE INSTALLATION OF A SKIMMING WEIR ON STOCKTON LAKE AND ITS EFFECT ON TEMPERATURE AND DISSOLVED OXYGEN IN THE LAKE AND DOWNSTREAM RELEASES

By

Raymond J. Vandenberg[1]

INTRODUCTION

The application of the principles of water quality data collection and management presented in this seminar to a field situation occasionally requires their alteration because of the occurrence of operational restrictions such as manpower, time, and monetary limitations, unusual natural conditions, and/or specific study objectives. A retrospective view of the development of a water quality program for a particular project and problem allows the analysis of such field modifications. Some changes will be found to have been justified. A few of these may even demonstrate the need for revision of guidelines inadvertently based on unattainable conditions. Other field decisions, upon analysis, will prove to have been made in error, and these should be corrected before the subject water quality program is continued. For these reasons, the case history of the installation by the Kansas City District of a skimming weir at Stockton Lake is presented and criticized. Additionally, this paper discusses the effectiveness of the skimming weir as a tool for solving the low temperature and low dissolved oxygen concentration problems frequently affecting releases from stratified lakes with bottom-limited withdrawal.

DESCRIPTION OF THE STOCKTON LAKE PROJECT AND ITS WATER QUALITY MONITORING PROGRAM

Stockton Lake, one of 11 operational lakes within the Kansas City District (KCD), is a 24,900-acre impoundment (at multipurpose pool elevation) on the Sac River in southwestern Missouri. The Sac's watershed covers about 2,000 square miles of the western portion of the Ozark Plateau. Stockton Dam is located 5 miles downstream from the confluence of the Sac River and its major tributary, the Little Sac River, regulating 60 percent of the drainage system. This project's designated purposes are flood control, power generation, recreation, fish and wildlife enhancement, and sediment storage. Stockton is a "peaking" power facility, generating upon demand by the Southwestern Power Administration.

[1]Aquatic Biologist, Water Control Section, KCD

The typical generation schedule has 8 to 10 hours of production per weekday during the summer months, and the average annual output is 55 million kw.-hr. Although there is no specified storage allocation for water quality releases to the Sac River, a nongeneration maintenance flow of 15 c.f.s. was made following impoundment, and this has been increased to 40 c.f.s. since 1975. Downstream releases during generation normally are between 5,000 and 8,000 c.f.s. Both the low flow bypass tubes and the turbine intakes are located near the bottom of the lake.

The KCD water quality surveillance program was being organized in 1968 as construction of Stockton Dam neared completion so the Corps of Engineers requested and received assistance from two other agencies concerned with water quality in order to conduct a preimpoundment survey of the project. The predecessor agencies to the Environmental Protection Agency (EPA) and the Missouri Division of Environmental Quality ran, respectively, the biological and chemical studies. Unfortunately, preimpoundment reports (2, 4) concentrated on existing conditions and did not address in detail all of the potential problems for the proposed lake. The Corps made no preimpoundment analysis of the probability for thermal stratification in Stockton. This failure to consider stratification and its associated effects during the design and construction phases was a major oversight in the water quality program for Stockton since there was existing evidence in the known limnological characteristics of neighboring lakes that stratification would occur. Investigation and solution of the release problem only after it was actually affecting the operational project cost the Corps adverse public relations and the possibility of attaining a more effective withdrawal system through redesign in addition to the necessitation of the expensive underwater construction method for weir placement.

Since impoundment began in 1969, monitoring of water quality at Stockton Lake has been intensive. For the first four years, monthly sampling was conducted from April through November with special, comprehensive efforts each August. General water quality parameters including heavy metal, nutrient, phytoplanktonic, zooplanktonic, benthic, and bacterial concentrations have been run in various combinations at sites on the inflows, the major arms and main body of the lake, and the downstream areas. These surveys were performed by two aquatic biologists from the KCD Water Control Section. Considerable assistance was provided gratis by the Missouri Division of Environmental Quality for all nutrient and heavy metal analyses and by the EPA for biotic parameters during the August comprehensives. The inter-agency cooperation developed by Water Control Section personnel is exemplary, and it comprises an important part of the water quality program. Unfortunately, because of the expanding workloads and operational limitations encountered by all involved agencies, studies on Stockton have had to be reduced to two surveillance trips annually during the past three years.

PROBLEM IDENTIFICATION

Data from the water quality monitoring program for Stockton Lake (2) show a fairly consistent cycle for the development and subsequent fluctuation of temperature and dissolved oxygen (DO) stratification. Following a complete spring mixing, the thermocline forms near the surface (from 10 to 30 feet in depth) during June, and, concurrently, an area of depressed DO concentration is established near the bottom of the lake. With time, the thermocline moves deeper into the lake, and the definition of the epilimnion, metalimnion, and hypolimnion becomes more distinct. The area of DO reduction expands in volume, encompassing progressively higher strata of the hypolimnion. The severity of the deoxygenation increases with time and depth, approaching an anerobic state. By late July or early August, the hypolimnion and the zone of DO depression are essentially identical; the thermocline lies at about 30 to 35 feet in depth. Anaerobic conditions exist throughout the hypolimnion from then until October. During the late summer period, the thermocline gradually drops to about 50 feet, and limited DO reduction also occurs in the enlarging epilimnion. By November, stratification is weakening. During that month, isothermic conditions are reestablished, and DO levels rise as strata mix.

Stratification on Stockton Lake was first documented in June of 1970, and at that time, it was recognized as a potential problem for meeting release criteria because of the bottom withdrawal design of the dam. The Sac River downstream from Stockton Dam has several state-designated uses, including the propagation of a warmwater fishery, and Missouri's water quality criteria specify that temperature variations from the stream's normal seasonal level should be less than 5° F and that DO should be above 5 p.p.m. Downstream degradation became evident during July 1970, when 20,000 fish died in the 3-mile reach downstream from the dam. Meetings were held between KCD and the water quality and conservation agencies of the Federal and Missouri Governments shortly after the fish kill was reported to discuss the cause and a solution. The principal problems identified were the low DO concentration and low water temperature of the release, although odor and pH levels were also in violation of Missouri's water quality criteria. Immediate remedial action was required so the Corps installed siphons in August 1970 to pass warm, well oxygenated water from the epilimnion of the lake over the spillway crest. Siphons were needed because the lake had not yet reached the elevation of the crest. The flow from the siphons, 15 c.f.s., mixed with a similar rate of release through the powerhouse and brought the temperature and DO up to acceptable levels. However, the siphons provided only a temporary solution since power generation, scheduled to begin in 1973, was to create a new set of release conditions. Greater epilimnetic spillway releases after the lake filled could not be made to counterbalance power

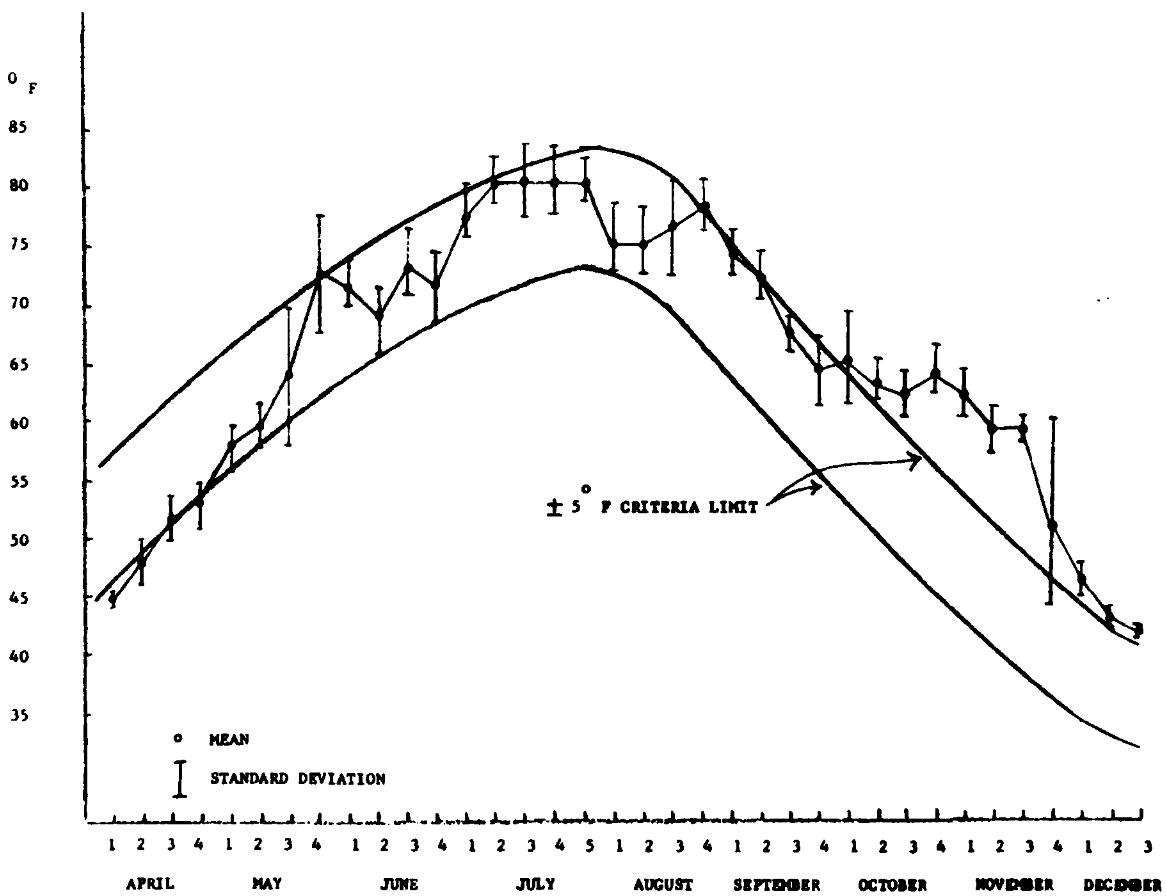
generation because neither lake storage nor the downstream channel capacity was sufficient. Consequently, a more permanent solution had to be developed by 1973. During these meetings in 1970, a skimming weir was suggested as a possible solution.

SOLUTION INVESTIGATIONS

Since the temperature and DO aspects of the release problem are related, thermal stratification modeling was chosen as the method to be used to find a solution (Stockton Lake Design Memorandum No. 24: Water Quality Improvement, Department of the Army, Corps of Engineers, Kansas City District, May 1972). In 1971, KCD defined a curve (Figure 1) delineating the acceptable range for release temperatures by determining

Figure 1

STOCKTON OUTLET WATER TEMPERATURES
1974



the average mid-monthly temperatures from the 5 years when records were available and applying the State's water temperature variation criterion ($\pm 5^{o}$ F). The District utilized the Hydrologic Engineering Center (HEC) program (1), incorporating Waterways Experiment Station (WES) selective withdrawal methods for the thermal stratification modeling. Coefficients for the HEC model were calculated from those already established for an adjacent lake with similar characteristics, and these coefficients were later verified using data from 1970 and 1971 for Stockton Lake itself. The years of 1962-1964 were modeled because of the availability of input data and the belief that stratification would have occurred in those years. The selection of the HEC program did restrict profiling periods to a one-month time interval, too long to adequately demonstrate the rapid variations expected with power generation. A second point subject to criticism in this modeling study was the restriction of input data to the 1962-1964 period.

The results of the HEC stratification modeling showed that strong thermal stratification developed. These computed profiles were then utilized in the analysis of several possible solutions. An air diffusion method of destratification was studied by calculating the energy required to bring the lake to the isothermal state each month. It was found to require over one-fifth of the total energy from power production of the project just to maintain destratification. Pumping of hypolimnetic water into the epilimnion to disrupt stratification was also studied by modeling. This hypolimnetic water was represented in the model as another inflow to the epilimnion at the temperature of the release and at a flow rate up to that provided by an 8,000 c.f.s. pump. Even with an unrealistically high mixing efficiency factor, that method was also found to be infeasible because of its large energy requirements. A third technique, the placement of a skimming weir across the approach channel, was simulated by assuming withdrawal occurred at the elevation of the crest of the weir. Unlike the other two proposed solutions, the weir is not an attempt to destratify the entire lake. Instead, it blocks hypolimnetic water from the intake area and allows epilimnetic water to be released. Initially, three different weir crest elevations were evaluated considering the ability of each to meet release temperatures, their effects on limiting power pool drawdown, and their costs of construction. The weir with a crest elevation of 840 ft., m.s.l., was determined to be the best. Since this evaluation had been made with the water surface elevation held constant at the 867-foot multipurpose pool level, the 840-foot weir crest elevation was then studied under a variety of pool levels to simulate possible annual variation. The modeling showed that release temperature criterion would be met except during the fall

when, for a period of time, all epilimnetic water was warmer than natural stream temperature. The projected release of warm water at this time of year was not expected to have a significant detrimental effect on the warm-water fishery of the downstream area. State and Federal agencies involved in the meetings on the problem agreed in late 1971 with the KCD decision that a skimming weir was the most practical solution, and they requested that it be installed as soon as possible.

The design memorandum recommending construction of the skimming weir was sent to the Missouri River Division and the Office of the Chief of Engineers (OCE) early in 1972. A value engineering analysis was conducted to determine the type of skimming weir to construct. The types considered included a cast-in-place concrete wall with either gates or stoplogs, a steel tank to be floated to and submerged at the site, an inflatable rubber dam, a plastic curtain, and a rockfill, broad-crested weir. The latter was found to cost the least over the life of the project. Additional modeling of a weir was requested by OCE to cover wet, dry, and normal years from the period of historical record and to provide a shorter time span for computer analysis of generation/nongeneration variation. The EIKER stratification model (3) was utilized since it allowed analysis on a 6-hour basis and incorporated the WES weir withdrawal program. The EIKER results were very similar to those of the HEC model except for the former's demonstration of an additional period in the spring when releases would not meet the downstream temperature criterion because of an absence of water in the lake with a high enough temperature. While this cold release would affect downstream biota, it is essentially an unavoidable effect of impoundment. The use of a skimming weir passing the warm surface water would minimize this spring release problem as much as possible. The EIKER modeling should have been done initially since it provided more useful information under the conditions of the study.

The rockfill, broad-crested weir was constructed in the spring of 1973. The rock was quarry-run limestone with a maximum weight of 2,000 lbs. Smaller sized rock was included to reduce seepage through the weir. The maximum velocity at the weir crest of 5 f.p.s. under maximum power pool drawdown (to within 5 feet of the crest) was not expected to transport any of the rock into the intakes. The quarry was located on the shore of Stockton Lake about a mile away from the construction site. Rock was barged to the weir area, about 1,000 feet uplake from the dam, and dumped into place. The height of the weir is 66 feet above the bottom of the intake channel, placing the 5-foot-wide crest 27 feet below the surface at multipurpose pool elevation. The 260-foot-long crest ties into the valley floor at an elevation of 840 ft., m.s.l., at both sides of the approach channel.

EFFECTS

The position of the crest of a weir in relation to the thermocline affects that weir's efficiency in providing epilimnetic skimming. The crest should be located well above the thermocline, minimizing the drawing of hypolimnetic water over the weir. However, at Stockton, the weir height had to be kept low so as to provide for adequate drawdown of the power pool, placing the crest within the zone of initial thermocline formation when the lake is at or just above the multipurpose pool elevation. Consequently, there is a period of time during the early summer of many years when weir effectiveness could be reduced by hypolimnetic spillage. This would reduce the water temperature of the downstream area and could detrimentally affect the aquatic biota. Fortunately, the DO is not severely depressed in the vicinity of the thermocline shortly after its formation so DO would remain satisfactory in the outlet area under such a spillage situation.

Profiles recorded during weir construction (Figures 2 and 3) demonstrate the problem of hypolimnetic intrusion into the area between the weir and the dam. In this case, the weir lay entirely within the hypolimnion because the crest was not yet up to its full height. Since the lake had been stratified for some time, the DO in the hypolimnion was decreasing, and this caused additional release problems. The profiles also show a variation between the generation and nongeneration phases of project operation. During generation, turbulent mixing of epilimnetic and hypolimnetic waters produced intermediate levels of temperature and DO downstream from the weir, which only marginally satisfied the water quality criteria for releases. During nongeneration (Figure 3), the area between the weir and the dam stratified rapidly as hypolimnetic water flowed freely over the weir. Stratification in this area became similar to that in the main lake after a few hours, and maintenance releases drawn off the bottom had low temperature and DO. Consequently, epilimnetic spillway releases were necessary to prevent downstream degradation during nongeneration periods.

Following the completion of weir construction, its efficiency improved, as is evident in the profile recorded during generation on 27 August 1973 (Figure 4). Restratification of the area between the weir and the dam still occurred during nongeneration but at a much slower rate than in July, taking 2 or 3 days rather than a few hours. The restratification was evidently due to seepage of cold, hypolimnetic water through the rock weir. This problem had been anticipated in 1971, but the thermal stratification computer programs utilized in weir analysis did not provide a means of projecting the probability of leakage or its severity. Since 1973, the restratification rate has progressively slowed. When long periods of nongeneration now occur, epilimnetic water can be released over the spillway to maintain downstream water quality.

Figure 2

TEMPERATURE AND DISSOLVED OXYGEN PROFILES DURING GENERATION JULY 10, 1973

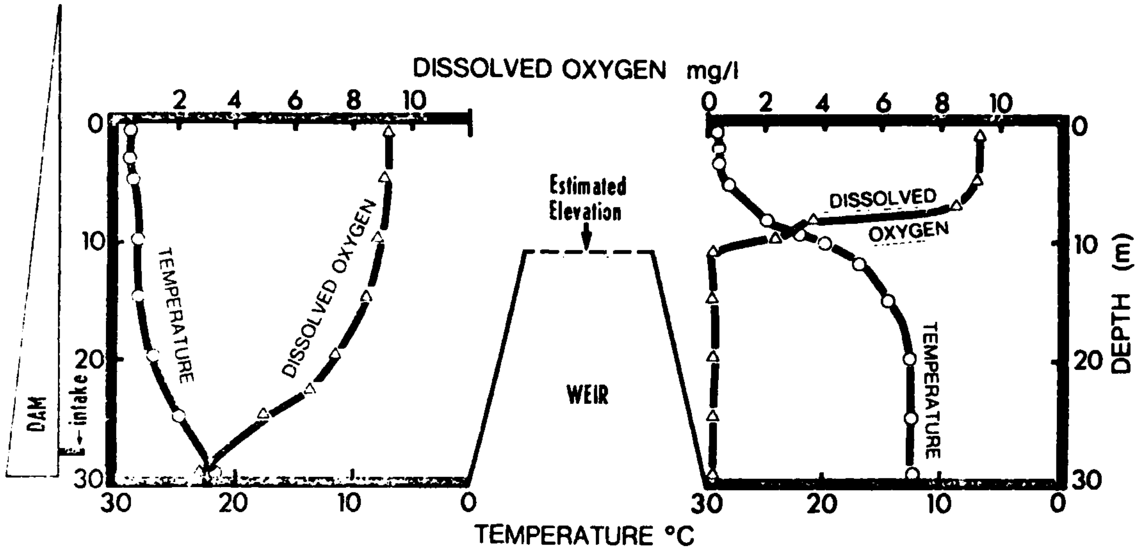
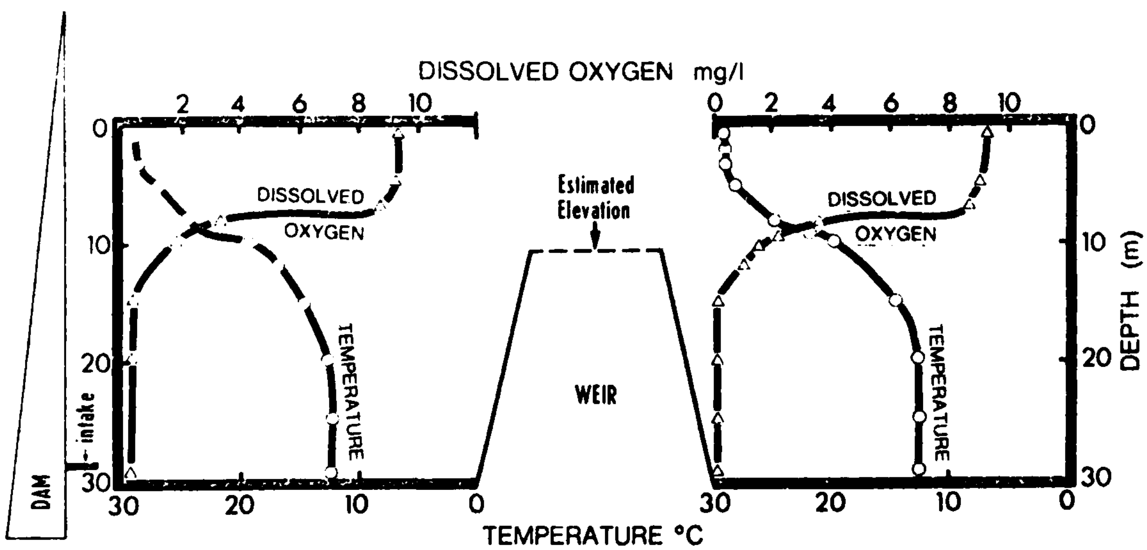


Figure 3

TEMPERATURE AND DISSOLVED OXYGEN PROFILES BEFORE GENERATION JULY 10, 1973



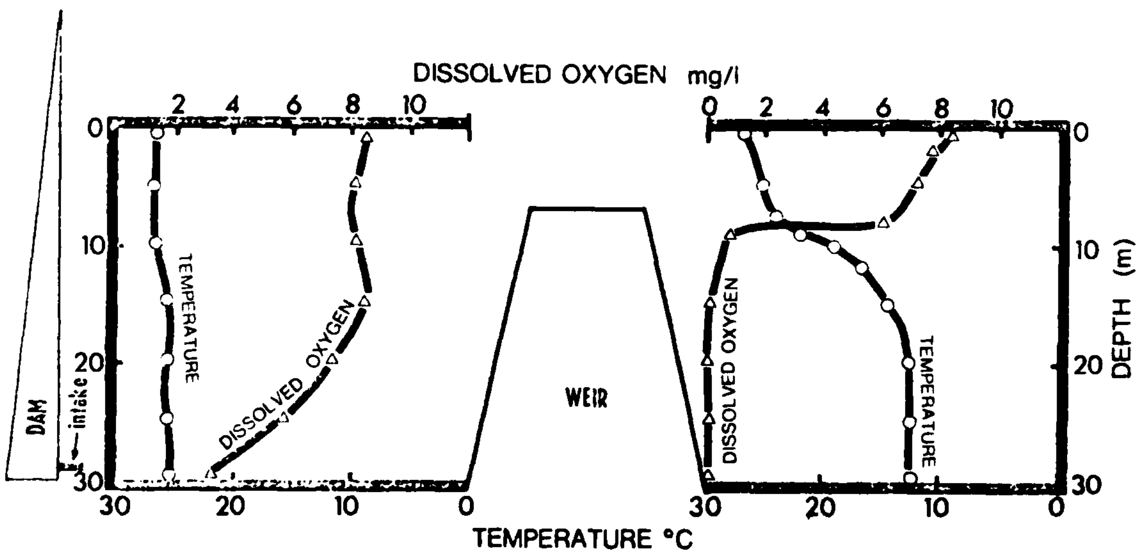
The skimming weir has been fairly successful in meeting the release curve adopted by the Corps. A continuous automatic monitor has been installed in the downstream area to record several water quality parameters including temperature and DO. The 1974 temperature records are shown in Figure 1. The EIKER model approximated these observed seasonal trends very well, indicating the lags in spring and fall caused by lake heating dynamics. Epilimnetic spillway releases made to increase DO levels during nongeneration periods probably caused some of the higher fall temperatures, but it was decided that high temperature releases were acceptable in order to keep DO above the 5 p.p.m. minimum.

Temperature fluctuation on a short time basis has just as great an effect on downstream water quality as the seasonal variation. Diurnal and shorter fluctuation periods have unfortunately been neglected by the Corps in its attempt to meet release guidelines. Figure 1 shows that the standard deviation from mean release temperature for each week during 1974 occasionally exceeded 5^{o} F. Greatest change usually occurs within one hour of the start of generation as the cold water which seeped through the weir is released. Such rapid variation in temperature can cause thermal shock downstream. Although this effect has not been proven to be a limiting factor on downstream biota because of the presence of several other problems in the outlet area, i.e., flow variation and poor substrate; the aquatic community probably is restricted by rapid temperature variation.

Figure 4

TEMPERATURE AND DISSOLVED OXYGEN PROFILES DURING GENERATION

AUGUST 27, 1973



Within the lake, the weir has had little adverse effect. There is some evidence that heavy metal concentrations are increasing, that the epilimnion is depressed adjacent to the weir during generation, and that seiches are established by the generation/nongeneration cycle. Further studies of flow velocity over the weir, seiches, density currents, and model verification would be of value for the complete analysis of weir operation, but since the main emphasis of the water quality program is on problem solving rather than "research," the limited resources available to KCD have been shifted to more pressing problems.

The procedures used in the analysis of the water quality problem with releases at Stockton Lake did result in some repetition and delay before the weir proposed in 1970 was installed in 1973. However, the major error was the failure to anticipate the stratification problem before impoundment. The experience gained with the Stockton program should prevent such an oversight from reoccurring in conjunction with the development of water quality programs at other KCD projects.

REFERENCES

1. Anonymous, "Reservoir Temperature Stratification - Users Manual," Hydrologic Engineering Center, U.S. Army Corps of Engineers, Sacramento District, Sacramento, California, Jan., 1972.

2. Anonymous, "Stockton Lake Water Quality Data," U.S. Army Corps of Engineers, Kansas City District, Kansas City, Missouri, June 1973.

3. Eiker, Earl E., "Thermal Simulation of Lakes - Users Manual," U.S. Army Corps of Engineers, Baltimore District, Baltimore, Maryland, Aug., 1974.

4. Thomas, Nelson A., "Pre-Impoundment Biological Survey of Stockton Reservoir - Sac River, Missouri," Division of Technical Support, U.S. Department of Interior, Federal Water Pollution Control Administration, Cincinnati, Ohio, 1969.

RELATING WATER QUALITY TO THE AQUATIC ENVIRONMENT: LIBBY DAM-LAKE KOOCANUSA PROJECT CASE STUDY

By

Ronald M. Bush[1/]

and

Thomas J. H. Bonde[2/]

INTRODUCTION

The importance of water quality study lies in the interrelationship of water quality with components of the aquatic ecosystem, recreation, aesthetics, public health, and water supply. This interrelationship, and the role water quality plays in a quality environment for man, is shown diagramatically in figure 1. Inherent in water quality criteria and standards is the establishment of water quality characteristics for designated uses. The goal is to protect man from the consequences of degraded water quality; the consequences are expressed in impairment in quality and/or quantity of fish, wildlife, recreation, aesthetics, public health, and public supply.

Several of the seminar speakers have emphasized keeping sight of the objectives for water quality study in carrying out a sampling program. The emphasis is warranted. It is altogether too easy to be lulled by data acquisition and tabulation, particularly when your time and energy are consistently commanded for bureaucratic and administrative functions. A finding of a level of x μg/l of dissolved "whatever" in a stream becomes quite meaningless within the context of our work at the Corps unless the value can be related to the impairment, enhancement, or status quo of the aquatic community and uses of that water.

In this paper we present examples from the Libby Dam-Lake Koocanusa Project water quality program that focus on water quality and relating it to the aquatic environment.

1/ Biologist, Seattle District Corps of Engineers, Seattle, WA.

2/ Biologist, Seattle District Corps of Engineers, Libby Dam Project Office, Libby, MT.

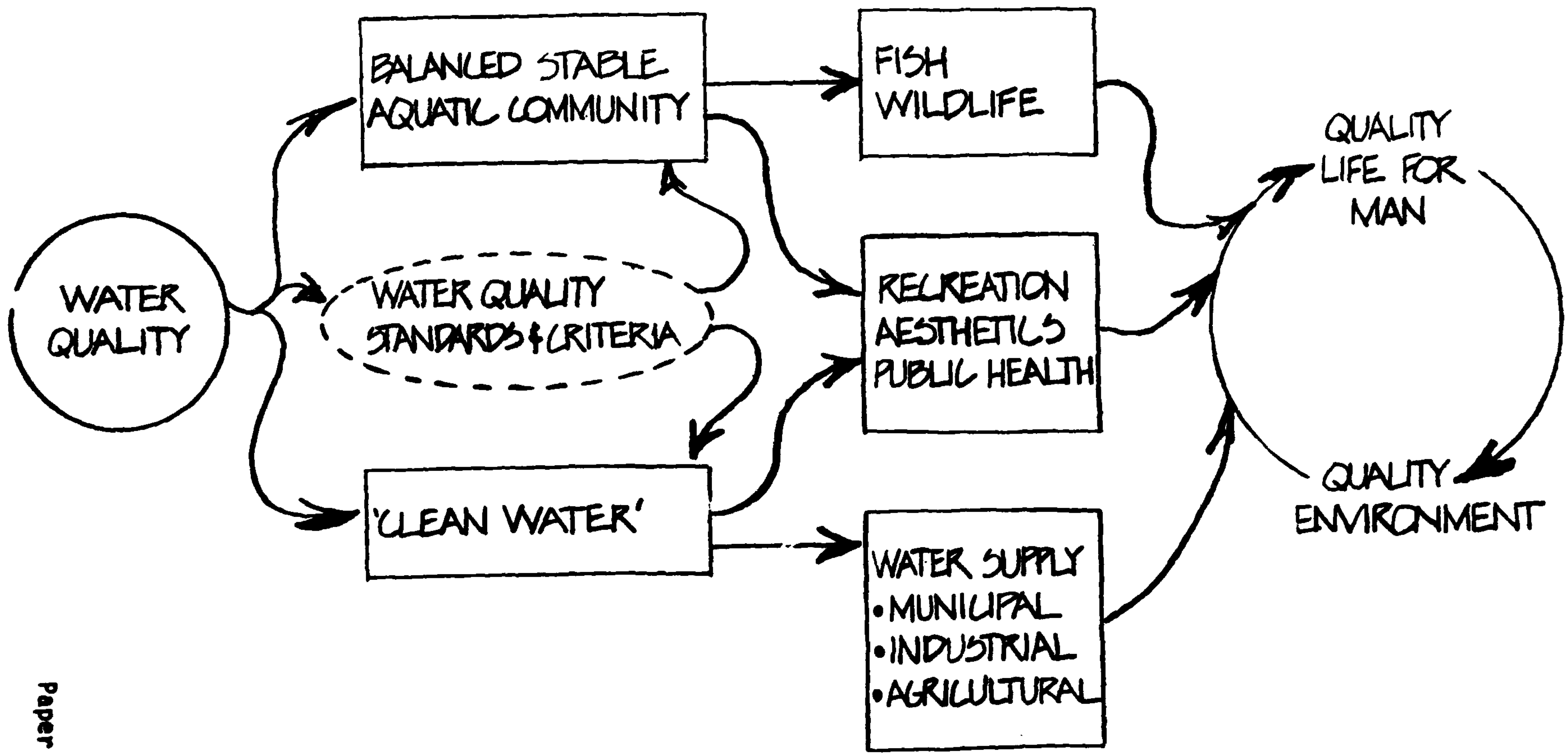


FIGURE 1. WATER QUALITY AND ITS RELATIONSHIP TO A QUALITY ENVIRONMENT FOR MAN.

LIBBY DAM PROJECT DESCRIPTION

Libby Dam is a multipurpose project located on the Kootenai River in northwestern Montana. Its location is shown in figure 2. The Kootenai River originates in Canada, enters the United States, returns to Canada, and flows into Kootenay Lake, eventually entering the Columbia River. The damsite is some 219 miles (352 km) upstream from the confluence of the Kootenai and Columbia Rivers, and about 17 miles (27 km) upstream from the town of Libby, Montana. The dam is a concrete gravity structure rising some 420 feet (128 m) above bedrock with a length of 2,955 feet (901 m) at its crest. Construction of the dam began in 1966 and the river was impounded in 1972 to form Lake Koocanusa.

Lake Koocanusa is a relatively large reservoir; at full pool it extends 90 miles (145 km), backing some 42 miles (68 km) into Canada. It has a surface area of 46,500 acres ($1.9 \times 10^8 m^2$) and a mean depth of 126 feet (38 m). Maximum depth of the lake is 350 feet (107 m), occurring in the forebay. Normal annual pool fluctuation is about 129 feet (39 m). Mean residence time is 0.69 years.

WATER QUALITY SAMPLING PROGRAM

The scoping of the Libby Dam Project water quality investigation began in 1966 with the Corps obtaining input from the Federal and state water resource and pollution abatement agencies. A particularly significant feature in the initial scoping was the insistence of the Federal Water Pollution Control Administration (FWPCA), now incorporated into the Environmental Protection Agency, that the Corps' water quality study relate changes in water quality parameters to changes in the aquatic environment. The FWPCA also suggested an aquatic biologist be stationed at the project to insure biological direction in the water quality program. The recommendations of all agencies were accommodated as much as possible in carrying out the monitoring program.

Monitoring of water quality and the study of benthic organisms was initiated in the Kootenai River in 1967. The monitoring program agreed upon by the Corps and the Federal and state resource agencies established that the Corps would assume responsibilities for water quality monitoring and biological studies on the Kootenai River above the town of Libby, Montana, while the FWPCA would assume monitoring responsibilities for the river from Libby downstream to the international border. Eight sampling stations were located on the river, and stations were established on three principal tributaries. Four of the river stations were selected for study of benthic organisms, two upstream and two downstream of the damsite. The sampling stations are shown in figure 2. Mutual concern over the quality of the water in the Kootenai River system led to a cooperative Canadian and United States study. In October 1969, the British Columbia Pollution Control Branch began sampling

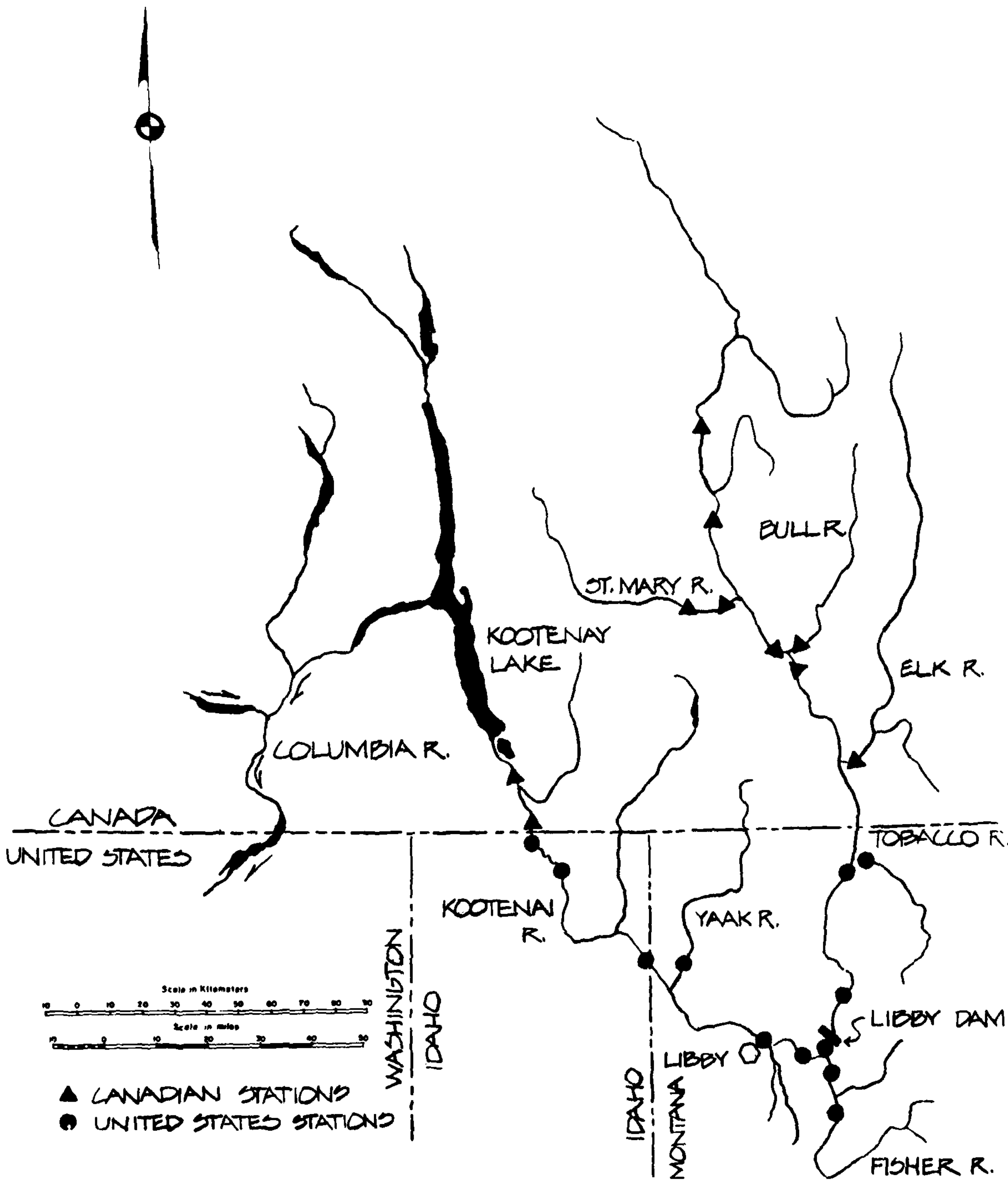


FIGURE 2 - LOCATION OF LIBBY DAM AND WATER QUALITY STATIONS ON THE KOOTENAI RIVER

four stations on the Kootenai River and three tributaries in British Columbia. This cooperation continued following impoundment of the river with four Corps and four Pollution Control Branch stations being established on Lake Koocanusa.

RELATING STREAM WATER QUALITY TO BENTHIC ORGANISMS

Through water quality surveillance and study of benthic organisms we were able to correlate changes in the aquatic insect population with changes in the chemical character of the river, both project induced and upstream (non-project) induced. In September 1968, an abrupt decrease in calcium, sulfate, fluoride, phosphate, and dissolved salts concentrations and conductivity levels in the Kootenai River was observed. The decreased concentration of these water quality parameters was attributed to partial treatment of an industrial discharge entering the St. Mary River, a tributary to the Kootenai River in British Columbia.

Concurrent with the reduction in the amount of industrial waste entering the river was a marked increase in the aquatic insect population at all sampling stations. Furthermore, the population of aquatic insects continued to be high throughout the remainder of the study. The relationship strongly suggests that the chemical changes in the river following the treatment of the industrial discharge had a beneficial effect on the insect population. We would like to point out that a failure of monitoring studies is that they can only show statistical correlations and suggest causal relationships at best; proof of causality requires some sort of experimentation. This limitation of monitoring programs should be recognized in both setting up of a surveillance program and analyzing the results. In support of our findings, the Canadian researchers found the effluent from the mining and fertilizer industry on the St. Mary river to contain toxic materials, particularly zinc and fluoride, which severely damaged aquatic life in the St. Mary River and adversely affected benthic organisms in the Kootenai River downstream of the confluence of the St. Mary River (2,8,10). Their studies did include bioassay experiments to demonstrate the toxic nature of the water.

Water quality problems observed from Libby Dam construction activities appeared to have been restricted to increases in suspended sediment and turbidity. Increased suspended sediment did appear to have adverse biological effects on the river as indicated by suppressions of the aquatic insect population up to 9 miles (14.5 km) downstream of the damsite. It is noteworthy that the effects of increased suspended sediment loading were somewhat offset by the wastewater controls undertaken in Canada. Even the most sensitive species of aquatic insects increased in the river both upstream and downstream of the damsite, although the increase was greater in the upstream stations.

Following closure of Libby Dam in spring 1972, a sharp decrease and change in species composition was observed in the aquatic insect population downstream of the dam. Water quality data showed dissolved nitrogen gas saturation levels between 130-140 percent immediately downstream of the dam, diminishing to 120-130 percent saturation near the town of Libby. Gas-bubble disease was suspected as being responsible for the dramatic loss of aquatic insects. To test this supposition, bioassay and flotation tests were conducted on aquatic insect larva. Laboratory bioassays demonstrated that larvae of stoneflies, mayflies, caddisflies, and midge flies were highly tolerant to dissolved gas supersaturation. Only representatives of one species of stonefly were observed with internal signs of gas-bubble disease. Most aquatic insect larvae were affected by loss of buoyancy control with resultant flotation (3). Flotation of insect larvae would result in mortality from surface exposure, starvation, and predation. Thus, although not causing direct mortality, gas supersaturation of the river waters would account for the observed change in the insect population. The effective blocking of downstream drift by the dam would further augment the decline in the insect population.

WATER QUALITY AND LAKE TROPHIC STATUS

The development of an extremely productive and potentially eutrophic reservoir upon river impoundment became apparent shortly after river water quality monitoring had begun. The concentration of phosphorus in the Kootenai River as it entered the United States was high, particularly in 1967, and 1968. Mean orthophosphorus concentrations for 1967, 1968, 1969, 1970, and 1971 were 0.52, 0.42, 0.08, 0.12, and 0.06 mg P/l, respectively. Total phosphorus concentrations for October 1969 through March 1972 averaged 0.20 mg P/l. Total nitrogen concentrations averaged 0.38 mg N/l for the same time period and two-thirds of the nitrogen was in the inorganic or available form. The literature on eutrophication of lakes available early in the study indicated that concentrations of 0.01 - 0.02 mg P/l and 0.2 - 0.3 mg N/l at the beginning of the growing season are critical levels above which excessive algal blooms could be expected to occur (4,7). Phosphorus concentrations in the Kootenai River were an order of magnitude greater than the publicized critical value and there appeared to be sufficient nitrogen and other nutrients to expect algal problems in the impoundment.

The potential for a eutrophic reservoir was an international concern, not only because Lake Koocanusa would extend 42 miles (68 km) into Canada during the summer months, but because the major cause of high phosphorus and nitrogen concentrations in the Kootenai River was a wastewater discharge from a single industry in British Columbia (2,5,6). The Corps of Engineers began voicing its concern regarding the potential for a eutrophic reservoir to the British Columbia government in 1968 and requested more stringent wastewater controls be imposed on

the fertilizer and mining plant in British Columbia. Believing the scientific data base inadequate to make projections on the biological condition of a reservoir yet to be formed, the Canadian government was hesitant to impose more stringent wastewater controls at that time and recommended the formation of a joint Canadian-United States task force to study Libby Dam project water quality concerns.

Accurate analysis and definition of a pollution problem is a difficult task at best. We were faced with the need to accurately project limnological conditions of Lake Koocanusa prior to its formation. In particular, would the reservoir develop nuisance algal blooms and other characteristics of eutrophic lakes which adversely affect recreation, aesthetics, fish propagation, and other uses of the water? To this end, much effort was expended towards improving the ongoing sampling program, obtaining professional assistance on data interpretation, reviewing pertinent literature and developing a model of the reservoir ecosystem. Essentially these efforts supported the belief that nuisance algal blooms would develop on Lake Koocanusa.

Following a request for their evaluation of project water quality concerns in 1969, the FWPCA projected that the "reservoir will annually experience serious algal blooms," which would "interfere with water-contact recreation, fishing, and aesthetics." The water quality conditions in a nearby reservoir provided insight on conditions to be expected in Lake Koocanusa. Kootenay Lake is located approximately 140 miles (225 km) downstream of the Libby damsite, and its principal inflow is the Kootenai River. The discharge of wastewater by the above referenced mining and fertilizer plant into the Kootenai River system has accelerated the eutrophication of Kootenay Lake. A 50-fold increase in surface water orthophosphate concentration was reported to have occurred in the southern portion of the lake between 1949 and 1967; the fertilizer plant began operation in 1953. Algal abundance has increased in the lake and extensive algal blooms have occurred as a result of the increased nutrient loading (5,6).

In hope of obtaining a good understanding of the reservoir water quality, the Corps contracted in 1972 for the development of a Lake Koocanusa mathematical water quality and ecologic model. Unfortunately, the status of the art in ecologic modeling was not sufficiently developed at that time to provide the degree of understanding that was needed of water quality and biological productivity in a reservoir system.

Subsequently, information on Lake Koocanusa was applied to a model developed by Vollenweider (9) relating phosphorus loading and lake trophic status. If phosphorus loading of the Kootenai River was to remain consistent with that found for 1967 through 1972, the annual total phosphorus loading to the reservoir would be in excess of 10 g/m^2, with 35 percent being orthophosphorus. For a lake with a mean depth and retention time expected for Lake Koocanusa, the "permissible" and "dangerous" phosphorus level in regard to

eutrophication presented by Vollenweider is 1.0 and 2.0 g/m^2. year, respectively. The total phosphorus loading estimated for Lake Koocanusa would be an order of magnitude greater than the permissible guideline, and dissolved phosphorus loading would be near four times the guideline relative to eutrophication. It is noteworthy that the guidelines are in good agreement with limnological experience for many well-studied lakes, including Kootenay Lake. However, Vollenweider is the first to acknowledge that the model sets forth only guidelines; it may not hold for any one specific situation. Only a few of the many factors governing a lake's biological activity are integral parts of the model. Furthermore, reservoirs are quite different than most lakes, particularly in their physical limnology.

By no means could it be absolutely proven that Lake Koocanusa would develop nuisance algal blooms, but we were quite confident that if the level of nutrient loading observed in Kootenai River continued, Lake Koocanusa would have blooms. The extent other characteristics of eutrophication would develop, such as hypolimnetic oxygen depletion, was unknown.

POSTIMPOUNDMENT WATER QUALITY

As projected, nuisance algal blooms did occur in Lake Koocanusa. Massive surface scums of *Alphanizomenon flos-aquae*, a blue-green algae characteristic of eutrophic waters, covered large areas of the lake in the fall of 1974 and 1975. No bloom was observed in 1976. Without a thorough evaluation of the data, it is uncertain why no bloom developed last year. Phosphorus levels in the lake were lower than observed in previous years as a result of rather stringent wastewater controls imposed in late 1975 on the mining and fertilizer plants on the St. Mary River in British Columbia. The decreased phosphorus loading may well have been a major factor controlling the development of a bloom. Other factors which undoubtedly played an important role in controlling the biological production in the lake were increased runoff in late summer and lower water temperatures as they influenced reservoir hydrology, flow patterns and thermal structure. Preliminary evaluation of lake data indicates that physical properties are among the principal factors controlling the lake's biological condition.

Although quite rigorously monitored for many water quality and related parameters, the Lake Koocanusa environment is not well understood. For one thing, the mass of data compiled has not been thoroughly evaluated. It is almost five years since the lake was formed, and a major effort towards postimpoundment data evaluation has just begun. Inhouse funding and manpower have been increased and short term, intensive studies of lake dynamics are being planned to forward information that cannot be gained through a surveillance program. The lag existing between data acquisition and data evaluation in the Libby Dam postimpoundment water quality study is an example of a major problem

that can occur in carrying out a water quality program. The precursory review of the data to identify potential problems, the preparation of preliminary assessments, and the continuation of water quality sampling does seem to satisfy immediate needs. However, in order to identify water quality related problems and provide the project with guidance and recommendations to meet environmental quality objectives, complete and up-to-date evaluation of the data is required.

The need to understand the limnology of Lake Koocanusa and predict its future status still exists. Although the lake has developed extensive algal blooms, it nevertheless does display many distinctly oligotrophic characteristics. Factors controlling the lake's productivity and the lake's ability to assimilate nutrients without developing nuisance conditions are unclear. Furthermore, three additional principal alterations to the existing lake environment are projected. These are, decreased nutrient loading as a result of further wastewater controls being undertaken in Canada, changed lake hydraulics with operation of a selective withdrawal system (to be operational this spring), and potential for decreased inflow resulting from diversion of Kootenai River waters into another drainage in Canada.

REFERENCES

1. Bonde, T. J. H., Bush, R. M., "Kootenai River Water Quality Investigations, Libby Dam Preimpoundment Study, 1967-1972," Seattle District Corps of Engineers Seattle, Washington, Oct., 1975, 124 pp.

2. Crozier, R. J., Leinweber, L. R., "Libby Dam Preimpoundment Study," British Columbia Department of the Environment, Victoria, Canada, Dec., 1974, 166 pp.

3. Fickersen, D. H., Montgomery, J. C., "Dissolved Gas Supersaturation: Bioassays of Kootenai River Organisms" Final Report to Seattle District Corps of Engineers, Seattle, Washington, Mar., 1974, 23 pp.

4. Mackenthun, K. M., "Nitrogen and Phosphorus in Water," U.S. Department of Health, Education, and Welfare, Public Health Service, 1965, 111 pp.

5. Northcote, T. G., "Some Effects of Mysid Introduction and Nutrient Enrichment on a Large Oligotrophic Lake and its Salmonids," Verhandelingen Internationale Vereinigung Limnologie, Vol. 18, Nov., 1972, pp. 1096-1106.

6. Northcote, T. G., "Some Impacts of Man on Kootenay Lake and its Salmonids," Great Lakes Fishery Commission, Technical Report No. 25, 1973, 46 pp.

7. Sawyer, C. N., "Fertilization of Lakes by Agricultural and Urban Drainage," Journal of New England Water Works Association, Vol. 61, No. 2, 1947, pp. 109-127.

8. Sinclair, D. C., "The Effects on Fish in the St. Mary River of Wastes from Consolidated Mining and Smelting Co. Operations in the Kimberley Area," British Columbia Department of Recreation and Conservation, Fish and Wildlife Branch, Victoria, Canada, May, 1966, 11 pp.

9. Vollenweider, R. A., "Input-Output Models," Canada Centre for Inland Waters, Burlington, Ontario, 1973, 48 pp.

10. Water Resources Services, "Kootenay Air and Water Quality Study, Phase I, Water Quality in Region 4, the Lower Kootenay River Basin," British Columbia Department of the Environment, Victoria, Canada, Mar., 1976, 190 pp.

SUMMARY & DISCUSSION

Seminar Summary by Earl Eiker

What I'd like to do in the next few minutes is summarize and emphasize what I saw as the important points covered during this seminar, then continue with a general discussion on whatever topics you're interested in talking about.

The intent of the conference was to provide a broad overview of a wide range of topics, although they were confined within the sphere of water quality data collection and management. After hearing some of the discussions there were a few people, at least, who came to this conference with the hope that they would walk away and have some kind of a magic cookbook formula to set up data collection programs and carry them out. I think it was evident from the presentations that every project is unique. The study at Libby is different from the study at Stockton, even though they are both reservoir projects. Each investigation requires a different approach to evaluation. It requires looking at the problem, defining objectives properly, and determining on a case-by case basis the type of sampling, parameters to be measured, frequency of sampling and location of sampling stations. These questions can't be answered at a conference like this and for that matter they can't be answered in training courses. They can only be answered by having knowledgable people with a dedication to getting the job done.

The thing that I keep hearing in OCE from the field is we need guidance, we need guidance. I certainly would't stand up here and pretend that I know what you want in terms of guidance. Sometimes it comes through as bodies and dollars, other times it comes through as a person saying, "tell me what parameters to measure and where you want them sampled." That's not the kind of thing you can do from OCE or for that matter from the division level. It has to be done in a district office by the people who know the projects, understand the problems, have clearly defined objectives and are willing to carry them through. Keep in mind that it's an extremely difficult proposition to get any kind of guidance out to the field at all, and I wish that everyone would think about that when they run into problems with what comes down from OCE. I would like to make a request. If you have a problem in interpreting what's in an ER, write a letter and ask for an interpretation or give someone a call. Whoever's symbol happens to be on the top, give him a call and put him on the spot. Find out what he wants and what he needs.

Water quality studies are multi-disciplinary in nature. It takes hydrologists, biologists, chemists and any number of other disciplines to solve water quality problems. Not only is water quality multi-disciplinary in that sense, but also in the sense that it includes planners, engineers and construction and operations personnel. We must all work together to get the job done. If the planner doesn't consult with the engineer about whether something can be built, we're going to have some problems. If the engineer doesn't tell the planner what can be built feasibly, we're going to have problems. If the engineer doesn't know what the man in the field can operate, we're going to have problems. If the person in the field operating the project doesn't let the planners and the engineers know what his problems are then it's never going to be straightened out. Of the attendees at this seminar, roughly 40% were planners, 40% were engineers, and 20% were in the construction/operations. These problems are obviously across the board, and not confined to only one group.

It was mentioned that the people in the field offices need to work more with the people in the labs. There's been two very good examples of this type of cooperation in the last several months. One has been the work that the New England Division did with the Hydraulics Laboratory at WES on the Dicky Lincoln project. The other example is the St. Paul District's work with the Environmental Effects Lab in connection with the LeFarge Lake Project. A lot of fruits have come out of these cooperative efforts.

We have a large amount of expertise within the Corps, and I think the first place we should look for help is within the Corps, but if people don't look, they're not going to find it, because it's not going to come to them. I think the people who made the presentations demonstrated this. We had presentations from three district representatives, two divisions, three technical divisions within OCE, two labs at WES, and there were any number of people who offered thoughtful comments during the conference, So we really do have a lot expertise, and what we need to do right now is use it. Also along these same lines, the question of doing work in house or by contract was addressed by many of the speakers.

The final thing that I'd like to mention, and to me it's the most important of all, is the personnel aspect. No matter what we do, if we're going to be successful we've got to have the right people, they've got to be properly trained, and they've got to have the proper experience. One area where this is apparent is the Division laboratories. There is a real question about the data that we're getting out of some of these labs, for a number of reasons. So it's something that we really need to be working on. We in the office have to work with the people in the Division Laboratories and vice versa.

All right, I quess it's open to anybody who wants to ask a question, or make a comment. I would make a request that because we want to

record some of this that you go to the microphone, there are some of them scattered around the room, then we'll all be able to hear you.

Open Discussion

Jack Rose (Omaha District): I feel that on a lot of the special studies the Corps is getting into, there is a lack of money alloted to engineering studies, which includes water quality. For instance, we have the Lake Manawa study near Omaha. Only about 5% of the total budget is proposed for water quality studies. Another example is the eastern South Dakota lake study which is a $100,000 plus study. Again, water quality is going to assume a very minor role. These problems exist and I don't think it's Omaha District along that has this type of problem.

Earl Eiker: You're absolutely right, it's not a problem unique to Omaha District. I don't know what you can do about it. I don't know how much help you'd be able to get from the division. I don't know how much sympathy you have within your own district but that is where any water quality program must be sold.

Al Harrison (MRD): In all new investigations the EIS is supposed to be a part of the feasibility document, and that implies work that's necessary to get the background information for the EIS. It is through that vehicle water quality investigations should be funded however, generally there is a lack of funding for this purpose. Particularly when in many offices the planning element is fighting for its life, trying to meet its payroll, and they are not as likely to designate funds to go to other elements.

Earl Eiker: Mark mentioned one thing on your money question, Jack. There's often an opportunity to use construction funds to get a study under way a little bit early.

Al Harrison: The key moment in the process to get your money is the preconstruction study. It's the time the plan of study is put together, and that's when engineering's input should be there, and often it is not.

Jack Rose: Yes, this is the point I was trying to make. This would appear to be an area that the Water Quality Committee could take a stand on. I was particularly happy to see that you are planning to have a higher level management type of meeting within the short term future and I think this could be a subject discussed at that time.

Earl Eiker: That's a very good point.

Dr. Anthony (ORD): This funding problem is universal, and it certainly has permeated the whole history not only of water quality but the whole environmental aspect. We've found in ORD that planning elements never did have enough money to conduct the kinds of surveys they needed to do. We have always been forced to furnish them freebies in terms of whatever input we had into these planning needs in terms of reports and so forth. This has impacted on the O&M budget. Virtually all of our efforts right now are dependent upon O&M funding. We've used O&M funding for planning scope surveys, pre-impoundment work and we've used it for R&D. Construction funding has always been available to us. It becomes a problem more of knowing what your objectives are, from well before the time the construction takes place. For example, a new mining area opens up on a watershed, and you see a need for a intensive type survey that you had not predicted before construction. Here is an example of being able to tap construction funds as a possibility. This aspect of budgeting is one I don't think anybody in OCE can give you much of a hand in. I think this is completely a division or a district problem. I think it's a factor here again of making sure that everybody in the office is aware of your program and the needs.

Jack Rose: I think we all have to admit that the O&M monies are a blessing to us, since they pretty well take the bite of it over the term of a year. But from what I've heard, it appears that we're going to be faced with zero budgeting in the future, and this is going to compound the funding problem.

Milt Millard (OCE): Let me respond to the budgeting a little more fully. There are several reasons why we're having this problem. Number one, I think the water quality program has not been sold throughout the districts. Unfortunately this started out with a directive from OCE saying initiate monitoring programs. Many of the districts did not define their program, they just went out and started sampling, setting up monitoring systems, and acquired data. The data was stored in some computer, and it sat there. Nobody realized any benefits from it, nobody knew why this was being done. The O&M budget has been going up since about 1969 at a rate of about 5% a year. Inflation has been running well over 10%, so we've been falling behind on O&M programs. During this same period we have new programs coming into our mission. We have increased emphasis now on recreation, fish and wildlife, and water quality. All this required funds that had to compete with the normal operation and maintenance. Over this period there's been an unfunded O&M requirement excluding capital expenditures that has gone up to over $300 million, and this is what you have to compete with in the water quality program. Now we go into zero based budgeting for the 1979 budget; the one that the districts are starting to work on. There

are directives that should be out within the next couple of weeks on this system. This will apply to both construction general, and O&M funds. Now basically under the zero based budget concept, every work item or group of work items, whether it be in water quality, recreation, or any other thing, will have to be prioritized within the district and eventually compete with every other work item or group of work items within the Corps. So theoretically, if New England has one work item, if it's not a higher priority than a work item down in the Southwestern Division, then the New England work item will be put aside until its priority comes up. So it's going to mean defining this work in water quality, setting up objectives, selling people on the value of it, what you're getting for it, how it's being used, and it's going to take a lot of effort on everbody's part. The thing to keep in mind is that the program has to be sold to people in operations, in engineering, and in planning who are not directly involved in water quality. We have to establish communications within the district and between divisions. We have tremendous expertise in the Corps, but we aren't fully using it. We're reinventing the wheel, we pay for some of the same programs many times over, because people haven't bothered to call the adjacent district or call somebody else who may have gone through this experience. All this is taking money. We're yelling we don't have enough money for water quality, and then we turn around and because of a lack of a few phone calls, we pour additional money down the drain or we spend money to repeat something. I hope the seminar has provided you with a chance to meet some of your colleagues in other districts and divisions and that you'll take advantage of this meeting. Get on the horn when you get back and call. A telephone call is awfully cheap, and even if it's cross country you may find somebody up in the North Pacific Division that has had some experience in an area that would be applicable to a problem down in the South Atlantic Division. And use this to get the most out of our dollars.

Earl Eiker: Does anybody else have any comments? We would like to have an oral critique on the seminar. I don't know if anybody's inclined to get up and speak their piece, but there are a couple of lines that we could pursue, Do you want to have more of these seminars? What type of topics would you like to see covered? Maybe even a suggestion as to a location for the meeting. In general terms, what anybody thought of the conference. Does anybody have any comments?

Gerry Loesch (St. Louis District): Overall I thought the seminar was very good. Many interesting points were brought up. I would like to see more seminars like this in the future, and one possible area is data interpretation. A day or a day and a half could be spent on that particular area, giving different case studies or different methodologies, expanding upon what was covered this morning.

Joseph Dixon (LA District): We come to these seminars and hear you talk about reservoirs of water but we don't have that situation where we are, and there are other districts like us. In talking at lunch I found out that NED has some dry reservoirs too. This gets back to your point that we need to have more inter-district communication. I would like to see a little emphasis placed on some ofthe water quality problems in the arid districts. I don't know how much expertise exists there, but I would appreciate sharing our experiences and having someone share theirs with us. Another point is that we don't have surface water quality problems, we have ground water quality problems. I can see some tie-ins between the Corp land use systems and the ground water quality management aspect.

Howard Reese (MRD): I would like to hear some discussion about the ECO models in regard to biological parameters. I think it might be worthwhile to have Dr. Rex Eley and Jerry Willey briefly indicate where we are today on the ECO models that we are working with. Have we got something that's worthwhile yet?

Jerry Willey (HEC): There's always a lot of confusion about various water quality models that HEC's distributed, so I'd like to take just a few minutes and try to clarify the various versions and briefly mention the differences between them. First of all, we have a library version of the Water Quality for River-Reservoir Systems (WQRRS) Model and the latest documentation on this is dated September 1975. This version is the one that's generally available to the public and is distributed worldwide on request. This model is capable of evaluating the physical, chemical and biological parameters for river-reservoir systems. We recognized a limitation in the river portion of the model; particularly after the Crops started into urban studies. The model has a steady flow river routine. We contracted to have the model modified to include dynamic stream flow routing capability. The initial model was developed and used on the Trinity River for low flow problems, so this steady flow model was fine, but as we got into urban studies we needed a dynamic routing routine. The modified version is also called WQRRS. The draft 1977 documentation is out and being distributed on request. The reason why it's draft right now is that it's undergoing review at the Waterways Experiment Station. This modified model has been released to about a dozen different people worldwide at this point with the understanding that it's a research tool, probably has some errors in it, and that it hasn't been fully tested yet. We will release it in a more general way around October 1977. On advantage of the new model is the new streamflow routing routines. The steady flow routines that were in the original model included the backwater method and the capability of inputting stage-flow relationships at any number of stations. The new model has not only those two hydraulic options but also the Muskingum routing method, modified Puls routing, kinematic wave, and the St. Venant equations which are the complete one-dimensional differential equations of motion. The 1977 version of the model is capable

of disconnecting the parameters, so that if you want to use WQRRS for a reservoir temperature analysis only, you have the capability. If you want to use it for stream temperature, BOD and DO, you have that capability. You have the capability in the model to either completely disconnect the parameters or to hold any of the parameters at a constant average level and simulate the impact of that average level but not dynamically simulate the parameter. Earl suggested we might mention what we've been working on besides model development. A recent HEC study used the 1977 version on the Chattachoochee River in Georgia near the city of Atlanta. It was an urban study. We looked at the impact of sewage treatment plants, advanced treatment out of the plants, and the impact of urban storm runoff. We're presently looking at the Oconee River basin in Georgia near Athens on a flood-plain information study, and trying to find out if you get any value out of looking at water quality for a limited number of dollars. We put about one-fourth of the money we normally would into the study and will see what we can derive in the way of looking at impacts from changing land use in urban areas, like Athens. We've done one river temperature study using the river model when we disconnected all the other parameters. We have used the river model in the past for analysis of locks and dams as well as re-regulation reservoirs.

Dr. Rex Eley (WES): Modeling is kind of a broad subject. River and reservoir modeling is one type of modeling. There are a number of other types. Making a few comments will probably create more problems and get me and other people in more trouble than not saying anything. The models that Jerry refers to are much better for quantity parameters and temperature than they are for other quality parameters. There are a lot of things that they can't do at the present time. They are not capable of considering anerobic conditions, they don't adequately consider the suspended solids routing, and therefore they have significant limitations when you're trying to evaluate the effects of turbity on water quality. We have just recently been making modifications to consider wind mixing. A number of the modifications that have been made over the last few years, in fact the models themselves in essence, are not verified in a predictive mode. So I think as Jerry indicated they have to be used as research tools. Out personal approach to it is that if there is a significant decision resting on the results that several approaches ought to be used to try to answer the same question, and if you come up with the same conclusion from several approaches, then you probably can have some confidence in it. But to assume that the model results can be used as an absolute prediction or as the sole basis for data interpretation and decision making probably is dangerous at this point for a lot of water quality constituents, in my opinion. I may be a little cautious, but as I indicated this morning there are a lot of assumptions, a lot of simplifcations, and all of these have dangers associated with them. It's not to say it's not a valuable approach, I think it is the approach of the future. I just

think there's a lot of work left to be done, I think you really have to know what you're doing you have to know the ins and outs of the model, and all of the assumptions, before you can properly apply it. There are situations where I don't think it's probably applicable. For example, if you've got a toxicity problem involved, the models as they are presently formulated do not adequately consider toxicity. Therefore, you can't expect the results to reflect what might occur in the case where toxicity is a problem. All these things have to be taken into account. There's a lot of research being done now to improve the models in a number of areas, both quantity and quality. I think some of the work Jerry has done on the river model has significantly improved the quantity aspects. I tried to make a few comments with regard to the state-of-the-art with several types of models this morning. We've taken a look I quess at about eight or nine watershed washoff models. There's significant problems there with quantity and quality. We've just got a long way to go and I think we're just getting started. I think the biggest value in modeling is that it is a tool by which you can integrate and give meaning to your data collection program. Perhaps data that we collect in the future will be more useful in modeling, whereas a lot of the data we collected in the past has not been. It hasn't been collected for a specific data analysis approach. I do think its a useful tool now if it's used by people who know what they're doing and they know the assumptions, they use other approaches, and then they use a lot of judgement in interpretation. I tried to discuss some of the approaches this morning that can be used in conjunction with it, we really didn't have time to resolve those. There are other approaches I did not mention. When I say these models aren't verified in a predictive mode, what I want to say is that any of these models, if its got a sufficient number of coefficients in it, you can take an existing data set and by judicious tuning or twisting of the knobs, you probably can reproduce the existing data set. The problem is when your in a preconstruction mode or a proposed action mode, you don't have any way of verifiying that the model has been put through adequate verification where a person tried to apply it as if a project didn't exist and then compared it to what the project really is like. There has always been tuning involved, and that really invalidates the verification procedure for a truly predictive mode. I think we've got to go through that before we really know how good or bad they are. One of the big problems as far as the water quality constituents are concerned are the assumptions of lumping large groups of organisms like species of algae and all into one or two single groups. Like I say, you model some average animal that doesn't exist in conditions that cen develop because of a tremendous change in a population of a species out there that may be important for one reason or another that the model wouldn't see.

Earl Eiker: Any other comments, questions, observations?

Jack Rose: I'd like to address one more thing. Has the Water Quality Committee looked at the possibility of consolidation of the Corps laboratories.

Al Harrison: I think Jack's point is well taken though I think it would be difficult to consolidate the laboratories. Maybe the consolidation of water quality capability at laboratories would be something that we could have an impact on.

Earl Eiker: The Water Quality Committee is presently looking at the Division Laboratory situation and could make a recommendation along those lines. I think in a lot of cases if we really took a fair and objective look at it, we might find that consolidation not only of laboratory functions but other water quality activities as well might be real appropriate. I'm sure that won't be universally true, but there are certainly some strong cases that can be made for that point of view.

Jerry Willey: Earl, I would like to bring up a point that district personnel have asked me about. You offered to talk about policy, so I'll put you on the spot and see what the response is. We have an ideal situation for discussion since there are a lot of district people and their division offices involved here. The Savannah District has a problem on water quality and they want to do some ecologic modeling including a look at some proposed run-of-river impoundments and increased withdrawals from the river system for water supply. The District has a model that HEC has calibrated for existing conditions. The District has several additional alternatives that they want to look at, but they cannot affort a man to devote his full time solely to running a comprehensive model, such as WQRRS. The first thing they do is turn to the labs and look for assistance, and in this case they find that WES doesn't have the time and manpower to assist them and neither does HEC. The District is left without a source of assistance that they consider viable. How do you suggest they proceed?

Earl Eiker: One possibility would be for SAD to form a group capable of performing modeling studies for all the SAD districts. Another might be to seek help from another Division or District office. Keep in mind if any Division wants to form such a group and can justify it, we'll give you all the help we can. You're not going to run into any opposition on this from OCE. Now if you're talking about forming a Corps-wide group to provide this assistance that might be a little bit tough. If we were to try to set up a group like this at WES, HEC, CRREL or anywhere that would provide this type of assistance, the problem would come down to spaces. You can work spaces within a Division, in order to set up a Corps-wide group to assist in these studies, somebody would have to sit down and decide, are we going to take one space from each Division, or how are we going to make up the spaces. On a Corps-wide basis, we've only got a certain amount of

spaces, and those are allocated out essentially to the Divisions and on down to the Districts. But I know, for example, at WES there's no way that they could set up a group with ten more spaces.

Jerry Willey: A man from the District doesn't really care whether it's Corps-wide or Division. All he's looking for is someone to do the job.

Earl Eiker: That's true.

Jerry Willey: I think that in this case the District's request would have been satisfied with a group in SAD to handle the job for them.

Al Harrison: I think these offices that have vital work to be done ought to be trained to the principle that there is no free lunch. They have to get out of the habit of looking around for someone else to do the job they have to do.

Earl Eiker: The problem really is, Al, that sometimes you only have one or two jobs like this. The type of modeling they're talking about may not be called for again.

Al Harrison: What about the ability of other Divisions or Districts to provide assistance.

Earl Eiker: It depends on workloads but a lot of expertise is certainly available within the Corps.

Jack Rose: It would seem that if the $40 million R&D program is directed to specific problems maybe there is an organizational and management type of effort that should be investigated.

Earl Eiker: There most definitely is, Jack. The whole organization and management aspect, the question of changing missions needs to be addressed.

Jerry Willey: Earl, do you think Corps-wide that there are some Districts that have personnel that are hurting for work and might be interested in seeing if they can find someone that already has some background in the general area of modeling and water quality, and develop that capability further by taking on jobs from other districts as long as funds are available?

Al Harrison: I think what Jerry means is treating that office as an AE.

Earl Eiker: Yes, this is a possibility.

Milt Millard: This brings back the thing of communications. I think that communication should be maintained between Districts. If such

a situation exists, it could be made known to others. That is, if a man in District A has a need, he can contact somebody across the country and perhaps find a capability that is not being utilized. Without the communication that's so necessary, it's never known and you have three, four people that may be sitting around doing the minimum of work and the other areas swamped. They could possibly arrange to have that work load shifted.

Earl Eiker: I am sure that when we came here everbody did not know who their Division Representative was on the Water Quality Committee. I think there are a few people, for example, that I could identify to give somebody a hand. There are several other people on the Committee who could identify people throughout the Corps. If the District does find itself in this kind of a bind, a call to his Division representative might locate someone that could give him a hand. If you're talking about ECO modeling, I think our ability to do that is going to be kind of short except if you were, willing to work directly with one of the labs.

Jerry Willey: That's exactly what we're talking about, because we're willing to work up to 100 percent of our time if we can see that technology is being transferred, but if we have to just keep taking the jobs on time after time with no technology being transferred, then it doesn't meet our objectives.

Speaker Unknown: Jerry, would you please elaborate on that point.

Jerry Willey: That looks like a gray area between what I said earlier and what I'm saying now, but we have certain R&D priorities and we have to set those aside to take on a special assistance job for a District. We're willing to set those aside to take on the assistance job if we see that the technology is going to be transferred to the field office so that they can do their future jobs themselves. If we don't see that, we're not willing to set the R&D priorities aside just to do their job for them.

Speaker Unknown: Then are you saying that if the District will furnish personnel to go to HEC to work through the modeling program, and get it completed that you are willing to provide the manpower at HEC to help the District do that? Is that what you're telling us? . Is that what you're telling us?

Jerry Willey: Yes. That's the offer we made to the Savannah District in this case.

Speaker Unknown: Do you have personnel on board that you could release to do this if the District furnished the money?

Jerry Willey: We'll assist you on your job and help you understand the modeling while you're there at HEC on your application. That sort of technology transfer must be a very important aspect in all the labs.

Earl Eiker: I think it is.

Jerry Willey: I think our labs are willing to work with you and help you get your job done as long as they see your real interest, not just your dollars, but your real interest by involvement from you.

Earl Eiker: Does anybody else have any comments?

Andy Andreliunas (NED): In response to something that Milt suggested, how would it be if each annual water quality report included a short narrative of what's going on in each District and then the Districts could see what other offices are doing?

Earl Eiker: In our rewrite of ER 1130-2-334 we are moving toward that. It's going to be the responsibility of the Divisions to supply me with certain information that I will need. What I intend to do is combine all the Division reports into a Corps-wide report and send it to the Division offices for distribution to the Districts. There's a need for revisions because of the many problems with the current ER. This is what I mentioned earlier. You just can't write a set of parameters, a set of this and a set of that, and the number of sampling stations and all that has to be done on each of those reports. You have to make it site specific so that the Divisions should be the one controlling what they need to get out of the District offices. Some of the Divisions are working this way already. It's just a matter of practicality. What's going to be coming into me from the Divisions will be along the lines of a summary, an update on what happened during the past year, specific problems, recommendations for modification of project operations, or anything along those lines that are of general interest, and then perhaps some kind of a discussion relative to what the Division's goals might be; where they want to be a few years from now regarding water quality programs within their Division. I'll then try to assimilate that and whatever other information might be of interest to the Division offices into a Corps-wide report. District reports will also be tied in with the reservoir regulation manuals and Division reports with Division water control management reports that are filed every year.

Robert Pearce (Kansas City District): What do you mean by reservoir regulation manuals?

Earl Eiker: Well, if you recall, the way the reporting was originally set up there was a basic report which laid down certain fundamental information and then a subsequent annual update. Much of the information which formerly was presented in the basic report will not be included in the reservoir regulation manual, things like the watershed description as it affects water quality, reservoir regulation procedures for water quality control and general background type information. It seems more appropriate to present this type of information in the reservoir regulation manual rather than having a separate basic document floating around. As far as the annual reports are concerned they will still be required

but their format and content will be solely up to the Divisions.

Robert Pearce: You aren't talking about making an annual addition to the reservoir regulation manual, are you?

Earl Eiker: No. It would only be updated as frequently as you update your reservoir regulation manuals. Whenever you update your reservoir regulation manuals, that's when the water quality information would also be updated. The annual report would address significant happenings within the District over the last year.

Robert Pearce: Of course, we have already done that; gone that route. But we view it another way. We have taken this annual report and used it to tell the reservoir managers. "Hey, we looked at your lake this year and this is the state we found it in." We have done this because they are concerned about what kind of quality of water they have. Also, we've gone back to the states with this information, and it helps our public relations with them. It has served a dual purpose. Now are you changing it on us again?

Al Harrison: Nothing is being changed. We can decide within our own Division what we need to do to be more effective.

Earl Eiker: We don't want to take away the dual purpose aspect.

Speaker Unknown: We need some sort of a technology transfer of papers, something like what EPA does. When EPA in a similar situation tell the states to go out and do something, they turn around and say here's the technology to do it with. They do this with a weekly or monthly or quarterly newsletter.

Earl Eiker: Yes, that would probably be good. Figure out the goings-on, what's happening now, where we are going and so forth. Much of this type of information will be contained in summary form in the annual Corps-wide report sent to the Divisions.

Jack Rose: The sediment program has an annual publication, doesn't it? It's my understanding that each district contributes this type of information and its put out once a year. It really wouldn't require that much editing.

Earl Eiker: The Corps-wide water quality report will provide a summary as to what is going on in the Corps divisions. Also, we can try to make a wider distribution of our committee meeting minutes. We should make sure they do get a wide distribution within the division and the district offices.

John Grace: I was wondering how many people here have seen the minutes of the committee meetings?

Earl Eiker: Not too many, judging from the response.

Dick DiBuono (NED): This pretty much falls in line with some of the thoughts we discussed in terms of information dissemination. It's something that's been on my mind now for a couple of years, in conjunction with design and planning studies, where a veritable wealth of information has been developed in various district offices for them by WES, for them by HEC, for them by independent consulting firms, or by them in special research studies conducted by themselves. This information rarely gets out of use by others. For example, I know WES, both in the Hydraulics Laboratory and in the Environmental Effects Laboratory, does a lot of project-oriented research activities in solving specific problems for a particular division or district office, and even though those documents are well prepared and disseminated throughout the Corps, when you get them at your office and they have a project name on them for another division or another district, you don't want to read through every one and ferret out that part that might be useful to you. Even though that would be a wise thing to do, you don't always have that time. I'd like to see in a future conference, or maybe this is something the Water Quality Committee could come up with as a topic for future study, a look see at how we can get information out of these reports, out of the design memos, out of the research reports that are done for project specific studies, and put in a more general form for use Corps-wide. I'm talking water quality now. I'd particularly like to hear from John Grace or Rex Eley or Jerry Willey on this subject now if they want to address it. If not, I definitely would like to bring this up for discussion at a future conference.

John Grace (WES): That's an excellent point, Dick. My feeling is it shows the need for something similar to our hydraulic design criteria. Perhaps you need something for, I hate to use the term water quality design criteria. But it is a tremendous job and what is needed is an organization or a center to collect this data, evaluate it and distribute it in a useful fashion.

Dick DiBuono: I know it's a great task, John. That's exactly it. There is a tremendous amount going on and a lot of us don't know that it's going on. Maybe some of us have a common problem to which we could apply a particular solution that has been developed in another office. I think we're getting enough work done in the area of water quality and water quality management, that principles are being established that should become standards for use by Corps-wide interests and disseminated throughout the Corps. I specifically think there's got to be some vehicle to get information out of design memoranda. I know there's a wealth of information in design memos that never goes any further than the district, division, or OCE files. The rest of the Corps never sees the good work.

There's a lack there that has to be satisfied somehow.

Earl Eiker: That's a real good topic for us to take a look at; the problems of technology transfer. It's an idea. I'm not saying the committee would have the time or the where-withal to do anything much on it, but to make a recommendation and come up with some ideas and at least help in word of mouth transfer of some of this information. That would be an appropriate task for the Committee.

Earl Eiker: Does anybody have anything else they'd like to say?

Walt Deane (Omaha District): I found the seminar was very valuable. The presentations were beneficial. However, I would like to see future seminars have a more narrow perspective; specific problems. Instead of ... like here we discussed all our institutional problems. I'd like to see a more narrow scope of future seminars, a series of seminars whereby we attack specific problems. Now, I don't know, that may sound like an abominable task.

Earl Eiker: One possible subject mentioned already is data interpretation, I think we can devote a lot more time to that particular aspect. We are looking to cut back on some of our data collection and put more effort into evaluation and intepretation of data. There is one other approach that we also might pursue. Both NCD and ORD hold Division-wide water quality workshops each year. Al Harrison has something similar to that in that you guys in MRD get together a couple of days a year. I think we need to be pushing out into that area a little bit more to discuss specific division problems and get into some important things that all the districts within a division are wrestling with. I've attended the last two at ORD and the last one at NCD and found all of them to be very productive and very worthwhile.

Jack Rose: I was wondering about something on the order of brainstorm sessions where each district would discuss his program that he had going on in fifteen or twenty minutes with a group-type discussion of ways that he could improve it, where others have encountered similar problems, and have corrected it. You know, a very abbreviated type session. Before you get there you would have everything pretty well in order.

Earl Eiker: I'm sure you would find an extremely large amount of common problems. It just seems to work that way. The observation of dry dams in the Los Angeles District and New England Division is a very good example. However, trying to have something like this by getting 39 districts together and having them present something for ten minutes, would probably lose a lot of the effectiveness you're looking for. This is the kind of thing that division works shops point towards. The possibility also exists to get other people in, maybe from three or four other districts scattered throughout the country for comparative purposes. That might be extremely helpful. That might be one way of compromising, to get at your suggestion Jack, and still recognize that getting all the districts together to discuss their problems would result in chaos.

Bob Brazeau (NED): Everybody's talking about data interpretation. I think when you get down to the nuts and bolts of it, before you can start to interpret data, the Corps has got to set up a policy on how we're going to go about our data collection program in the field. Some of us work out of EAP manuals, others work under different methods. There are several places we can go to get this information, there's also several places we can go to get the schooling. I think since we're all in the Corps, that we all should get the same type of schooling right from the ground up, right from the guy who goes out and picks up that sample and brings it into the laboratory to the laboratory technician. EPA used to have quite a few good schools, but now they're cutting down. They are not having many schools; so the chances of sending a man out to school are getting slimmer and slimmer, unless you want to send them to some type school in New York for $700 - $800 a week. Why can't the Water Quality Committee set up a training program in conjunction with EAP. I've talked to the people in training in OCE about this, and they say "We've got the money, all we're waiting for is for somebody to ask us to do it for them." We need to set up schools and training courses throughout the Corps, just like this conference, and have the people go to them. I mean there's 50 different courses I could mention that are worthwhile. You people set up the course with EPA and ask them to give it. They are excellent teachers and they've got a good program. But have them develop it the way you want it to work so we're all together on what we're doing. You can talk to people in one district, in one division, and they are on an entirely different tangent than you are, in sampling and field surveys and even laboratories. Let's have a standard. You set up the training you want and give it to us. I think you're going to get better data to interpret that way.

Julian Raynes (SAD): I'd like to point out that the USGS has picked up a lot of the training that EPA has dropped. You might try to get a catalog from them.

Bob Brazeau: That's true, but that's probably down in your area where they have the big laboratories. If you get a list of training schedules every time if comes out from OCE, it gets bigger and bigger. You can thumb through there until your thumbs come off, and the only thing you see is Jerry's HEC courses. But it's got nothing to do with the nuts and bolts of the business.

Earl Eiker: Training is one of the things that we're definitely taking a look at. I think we're sort of stymied right now about this data collection thing, I quess we all are, but we certainly will be looking at training needs. Does anybody else have anything?

Speaker Unknown: I have one thing. It would be nice for the committee to set up what each district's capabilities are, what their orientation

is, and what their objectives are. It seems every district or division has a different capability, a different objective. If every district had that list and has problems that they couldn't solve or didn't have the capability, then they would know what telephone number to call, and who to question.

Earl Eiker: That's a very good point. We made a start towards that by developing a list of personnel, we do have that available. The next thing we need to do is find out what each district is doing so we can get that down on paper; where you could get some expertise that's been identified. One other thing we did was list the division contracts that have been let in the last couple of years and the firms that performed them. So, for example, you could call your Division representative and if somebody in St. Paul had let a similar contract in the last year or two, you could get an idea of what contractors they used and what the feeling was from the NCD representative.

Earl Eiker: I have one closing comment. I would like to thank everyone for their participation. I'd like to particularly thank the speakers, Mark Anthony, Rex Eley, Bob Engler, Darrell Fontane, Richard Jackson, Gary McKee, Milt Millard, Jan Rasgus, Ray Vandenverg, Ron Busch and George Kincaid. Everybody put a lot of time in on this. I really appreciate it and I'm sure everybody on the committee does, and I hope that everybody that attended the seminar appreciated it too. Let's give the speakers a big hand. I'd also like to thank MRD for hosting this; Al Harrison and Howard Reese.

GPC 789-107/038